DISCOVERY

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Edited by L. Russell Muirhead

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IN THIS ISSUE

Strange Snakes from Australia

By Dr. Donald Thomson

◆

Man and Mosquito in Ceylon

By Dr. S. Vere Pearson

◆

Science and Religion: an Answer to Professor Julian Huxley. By Alfred Noyes (concluded)

◆

Selection Tests for Colour-Workers — The History of the Balance — Irish Antiquities — A Plant Hunter in the Sierras

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Notes of the Month.

Lectures and addresses of unusual importance have marked the close of 1934. Pride of place must be given to the anniversary address of the President of the Royal Society, Sir F. Gowland Hopkins, in which the announcement was made that recent research had led to the possibility of seeing the brain at work. This remarkable discovery, due to Professor E. D. Adrian and Mr. Brian Matthews, both of Cambridge, still awaits full development; and its undoubted importance in the realms of surgery and psychiatry has yet to be correctly assessed. By means of electrical records made through the skull various states of the brain can be recognised; but the "brain waves" thus recorded do not appear to be the result of thought-action. Fuller information as to their true significance is eagerly awaited.

* * * *

The Christmas Lectures at the Royal Institution, being "the one hundred and ninth course of six lectures adapted to a juvenile auditory," are now in course of delivery by Professor W. L. Bragg. The subject this year is Electricity, and Professor Bragg's lucid exposition is well adapted to others besides juvenile listeners. In his first lecture he demonstrates that we are at once faced with a difficulty when dealing with even the simplest electrical problems: we are not provided with an "electrical sense" with which to study the phenomena that come under the head of electricity. The subsequent lectures help to provide an excellent substitute for this missing sixth sense and will show at any rate that we know something of how electricity "works" and have been able to bind it to our service.

* * * *

Before the Society of Public Analysts, Mr. J. H. Coste, who demonstrated, in our issue of last June, the advantages and disadvantages of aluminium ware for cooking, dealt (accompanied by Mr. D. C. Garrett and Mr. R. H. Burns) with the problems of enamel ware for similar purposes. The danger in the case of enamel ware lies in the release of noxious antimony compounds by the action of acids; and a specification for acid-resistance of enamel ware has been evolved. It is not sufficient, in the manufacture of enamels, to avoid the use of known antimony compounds; the absence of antimony from all constituents should be ensured.

* * * *

During the long summer drought of 1934 the ancient craft of dowsing, or water-divining, came into special prominence. The December number of the *Journal of the British Society of Dowsers* contains some items of important interest. The summer meeting of the Society was notable for the addresses of Miss Evelyn Penrose, well known for her development of the art of tracing water *from a large-scale map*, and Capt. Trinder, who is an expert on the agricultural side of dowsing, including the determination of the sex of eggs. A paper by Dr. Dudley Wright is included, describing the development of medical diagnosis with rod and pendulum. It was found that dowsers, or radiophysicists, were able to test water for bacterial contamination; similar but much more delicate tests for the bacterial infection of living tissue have been developed from the elementary technique. It is perhaps an anti-climax to record the tracing by the divining-rod of a dog stolen and carried half across England.

* * * *

A great many intelligent people—not to speak of the others—still consider a museum to be a dead-and-alive sort of place; and we know of museums which go far to

justify their assumption. London, happily, is free from museums of the junk-shop type; but it is questionable whether the responsible authorities have succeeded in convincing the majority that their establishments are not inhospitably highbrow. Dr. Carlos E. Cummings, Acting Director of the Buffalo Museum of Science, has made a bold and (we should think) successful bid to convince his public that a museum is not "a dead file of moth-fodder." *Your Guide to the Buffalo Museum of Science* is a small pamphlet beautifully produced and illustrated, which should reassure the shyest potential visitor. It even has a plan, showing the best way to the museum, and it is priced at 15 cents. Other curators and directors may well follow his example; but they must also deliver the goods, as he does, when the visitors arrive.

* * * *

The *China Journal* reports that during the autumn of 1934, Mr. Ernst Schaefer, of the Second Dolan Expedition to West China and Tibet, made a record bag of ten takins (*Budorcas thibetanus* Milne-Edwards). It seems that while moving up the valley of the Tung river in the Kong-yu district, Mr. Schaefer and his native hunter became aware of a herd of takin on the opposite bank. By dropping the leader of the herd with his first shot, Mr. Schaefer turned the herd back, and he continued shooting until he had brought no fewer than ten of the animals down. This is a record which will probably never be beaten, for the takin is a rare animal and very difficult to hunt. It is most disappointing to read nowadays of the establishing of such "records"; and the takin will become even rarer than it already is if such feats are emulated by European and American big-game hunters. Western China is not at present in a state in which game-laws can be strictly enforced, and now that enlightened policy in Africa has put an end to the activity of "head-hunters," there appears to be a general rush to inner Asia with a view to hastening the extinction of such rare and interesting species as the various takins and the giant panda (*Aeluropus melanoleucus*).

* * * *

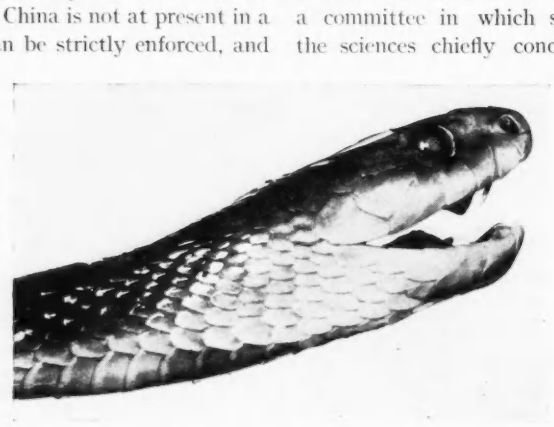
It is not often that the pages of *Hansard* yield material for those of *Discovery*; but Mr. Walter Elliot is universal. In answer to a question from Sir Basil Peto he stated that, in consequence of complaints by fishermen as to damage done by seals, the Cornwall Sea Fisheries Committee undertook a demonstration of humane methods of destroying seals during last summer. The humane killer, in this instance, was the .303 Service rifle, and the total bag so far (up to December 7th) was 177, of which 106 were killed after September 1st, when the close season for grey seals begins. Here we have a splendid example of bureaucratic control over-riding not merely the report of the Marine Biological Association, which (as recorded in our September number) found that the damage done by seals was negligible, but also the Grey Seals Protection Act, 1933. With Sir Basil Peto, we now wish to know what steps Mr. Elliot proposes to take to enforce the penalties provided by the said Act.

* * * *

As we go to press the report comes to hand of an address by Col. Mervyn O'Gorman before the British Science Guild on *Science and Road Traffic*. The lecture is published by the Guild at the price of one shilling. After indicating the scope of Road Transport as one of the industries necessary to the well-being of the State, and the danger involved in present traffic conditions, Col. O'Gorman appeals to Science for aid in assessing the improvement due to any change of traffic control, of road lay-out, or of road code, etc. It is not sufficient, he says, to count fatalities and casualties, but the flow of traffic also must be measured before and after the change. The business of evolving the necessary instruments, the analytical methods, the interpretation of data, and similar work on the accident ratio, is the proper function of Science. He asks for the establishment of a committee in which scientists might collaborate, the sciences chiefly concerned being physics, mechanics, mathematics, chemistry, geology, metallurgy, statistics and physiology.

* * * *

The announcement was made from New York during December that the molten glass for the second 200-inch lens for the world's largest telescope had been successfully poured, a precautionary measure in case the first lens, cast in March, should exhibit any imperfection. The lens weighs 20 tons and will be true to within one millionth of an inch.



The Taipan (Oxyuranus scutellatus), *the largest and deadliest snake of Australia. Its habits and its venom, and the fear in which it is held by the aborigines are described in the article which follows.*

Strange Snakes from Australia

By Donald F. Thomson, D.Sc.
Research Fellow, University of Melbourne.

Dr. Donald Thomson has recently returned from North Queensland, after his third successful expedition under the auspices of the University of Melbourne. He has lived for several years on Cape York Peninsula, studying the native tribes and the zoology of the area. The snakes, which include the largest and deadliest species in Australia, received his special attention and several species new to science were secured.

AUSTRALIA possesses many venomous snakes, all of them characterised by the possession of fangs with a more or less open groove for conducting the venom from the poison-duct, instead of a hollow tube as in the Vipers. Although the venom of many of even the common species, such as the Tiger, the Copperhead, and the Brown snakes, is considerably more potent than that of the dreaded Cobra, their bites are usually not as deadly, for their fangs are much shorter, and their biting apparatus less effective. Nevertheless, north-eastern Australia is frequented by one very large and extremely deadly species known as the Taipan, of which very little has been recorded hitherto.

The Carpet Snake (Python spilotes), *a non-venomous snake valued for its patterned skin.*

Here I shall speak chiefly of the snakes of Cape York Peninsula, in North Queensland, the home of the largest and also of the most venomous snakes in the Australian region. During a recent expedition more than two hundred snakes were secured, and a large quantity of venom obtained from some of them. It would indeed be difficult to avoid encountering snakes in the tropical north, for they are found in every kind of habitat—in fresh and salt water, in trees, on the ground, and even in burrows underground; and it is, moreover, not only in the day-time that they are found, for a number are either truly nocturnal or wait until the evening to move abroad. Before describing the specimens encountered in the field, however, it may be advisable to give a general account of the classification of Australian snakes and their descriptions so that they may be related to those of other countries. Although death from snake bite has never been the problem in Australia that it is in India, Africa, and South America, where there is a more or less dense population that goes bare-footed, there has been a number of deaths much larger than is generally realised, and in recent years a considerable amount of systematic research on Australian snakes, their distribution and natural history, as well as on their biting habits and biting mechanism, and venom and venom-yields, has been undertaken.

While there is a very large number of venomous snakes in Australia, varying greatly in their degree of dangerousness to man, all the venomous species belong to one family, the *Colubridae*, a group characterised by the possession of open grooved fangs, as distinct from the canalised or perforated tubes of the *Viperidae*, the family that includes, for example, most of the deadly snakes of South America. Not all members of the *Colubridae* are venomous, however, and the family is further divided into three groups according to the type and position of the fangs: the *Aglypha*, the *Opisthoglypha*, and the *Proteroglypha*, all three of which are well represented in Australia. The first group, the *Aglypha*, comprises the solid-toothed non-venomous snakes, among which are the beautiful and harmless Green Tree Snakes (*Dendrophis*) that abound in the tropical jungles of North Queensland. The *Opisthoglypha* include the so-called "back-fanged" snakes that have the fangs situated at the back of the mouth, such as the Brown Tree Snake (*Boiga fusca*)

which, unlike the Green Tree Snake, is nocturnal, and *Hypsirhina macleayi*—Macleay's Water Snake—a rather sluggish reptile that inhabits the rivers and lagoons of the far north. Unlike the solid-fanged snakes, these reptiles are definitely venomous although they are probably not very toxic to man. As a matter of fact, almost nothing is known in Australia about their venom or their biting habits, but it is certain that, whatever may be the potency of their venom, the situation of the fangs far back in the mouth places them at a disadvantage in biting large prey. While handling a specimen of one of these water snakes—to the bite of which frogs had succumbed rapidly—I was bitten on the finger, but no symptoms resulted, nor were any observed in the case of an aborigine who was bitten apparently also by a reptile of this species.

Finally, to the *Proteroglypha*—snakes having the poison fang on the anterior end of the maxilla—belong all Australian snakes that are dangerously venomous, including the Tiger Snake (*Notechis scutatus*), the venom of which is several times as potent as that of the Cobra (*Naia naia*); the Copperhead (*Denisonia superba*); the Death Adder (*Acanthophis antarcticus*); the "Brown" Snakes of the genus *Demansia*; and the extremely deadly Taipan (*Oxyuranus scutellatus*), the largest and by far the deadliest of all Australian venomous snakes, and one of the most dangerous snakes in the world.*

While there are about 100 species of venomous snakes in Australia (some writers place the number considerably higher), comparatively few are really dangerous to man, most of them being either too small to be formidable, others because they are rare or, on account of their habitat, unlikely to be encountered. Thus, for example, there are fourteen or fifteen species of sea snakes found in Australian seas, but most of these are comparatively rare, and they are practically confined to tropical and sub-tropical waters. Moreover, while the venom of the sea snakes, investigated in India, particularly that of the *Enhydrina schistosa*—a handsome bluish reptile banded on the upper surface—is very potent, sea snakes generally bite only under extreme provocation. By far the commonest of the really deadly snakes in Australia are those already mentioned—the Tiger Snake, the Copperhead, the Death Adder, the Brown *Demansias*, and certain of the "Black" snakes of the genus *Pseudechis*, which are met with commonly in south-eastern Australia. The Death Adder, however, only occurs in numbers north of the Murray River, and becomes really abundant in Queensland, where, although its venom is by no means the most potent, it is responsible for more deaths than any other species. In the southern part of the Continent venomous snakes far outnumber the non-venomous, not only in species, but in numbers, so that the layman is well advised to treat all snakes with caution.

The humid jungles, or "scrubs" as they are called, of Cape York Peninsula in the far north of Queensland are inhabited by a large number of interesting reptiles, of which very little is known. Since in the jungle the most abundant life is in the leafy canopy overhead, and the snakes must follow their prey—birds and mammals—or go under in the intense struggle for existence, most of the snakes of this region are arboreal. The most abundant of these arboreal reptiles are the Green Tree Snakes, which, coloured olive or blue-green, harmonise so perfectly with their surroundings that one may frequently almost touch them as they bask, without being aware of their presence until they shoot like arrows to the ground, and take refuge in holes, or in hollow trees. Less active and spectacular are the Brown Tree Snakes. Brown in colour, with blackish cross bands, and broad flat heads, they look evil and sinister when seen in the dark jungles at night. Although slightly venomous, they are not regarded as dangerous.

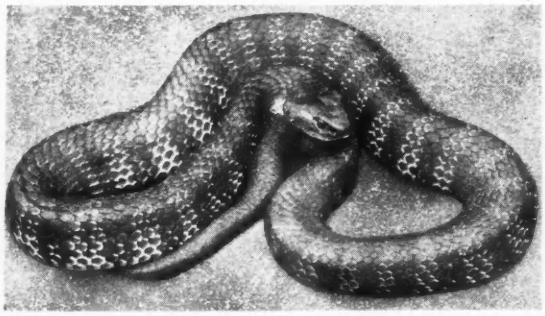
Dendrophis punctulatus, *one of the Green Tree Snakes, a beautiful and graceful snake, and quite harmless.*

We encountered a large number of other non-venomous snakes, including two Rock Pythons (*Liasis*) which attain a length of nine or ten feet, and share with the true Pythons the possession of a pair of well-marked vestigial legs at the sides of the vent, each leg equipped with a claw. Two species of true Python also are at home in these jungles, and in recent years a trade, long neglected in Australia, has been developed in their skins, which are

* *For an account of this snake see* Thomson, *Proc. Zool. Soc.*, 1933

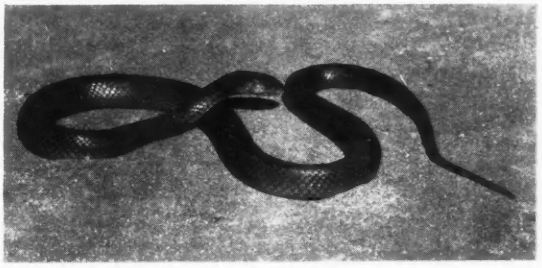
stretched and dried in the shade, and then sold by the foot, the price being fixed according to the width of the skin. The common species, *Python spilotes* var. *variegata*, is known throughout eastern Australia as the Carpet Snake on account of the beautiful reticulated pattern of its skin. It usually attains a length of nine or ten feet—in rare instances eleven or twelve. In the same jungles is found also the great Scrub Python (*Python amethystinus*), the largest of Australian snakes, which reaches a length of twenty feet or more, and is capable of swallowing a wallaby whole. The flesh of this really formidable reptile is much prized by the aborigines, who kill it with spears. Elaborate native food tabus restrict the eating of these snakes, which are greatly valued on account of their abundance of fat.

While the largest of the non-venomous snakes inhabits Cape York Peninsula, the biggest of the venomous snakes, the Taipan (*Oxyuranus scutellatus*), is likewise found in the same region. Almost nothing was known of the habits or natural history of this snake, nor of its venom or venom-yields, and we were fortunate, during the progress of the expedition, to secure a number of living specimens. This snake, which derives its name *scutellatus* from the escutcheon-like form of the frontal shield, was first noted in New Guinea by the German naturalist Peters, but its range has since been found to extend into Northern Australia. It attains a length of nine or ten feet, perhaps considerably more ; it moves very rapidly and is savage and aggressive. It frequents



The Tiger Snake (Notechis scutatus) *is common in south-east Australia and is extremely venomous.*

long grass, on the seeds of which subsist the rats and mice that are its chief food supply. The natives of the area hold it in great dread, for it is responsible for many deaths among them. We obtained details of many cases in which aborigines had been bitten, in each instance with fatal results, so that as far as this evidence went the mortality was 100 per cent. In one case a man had speared what he believed to be a bandicoot in



A giant Black Snake from Cape York, the Mulga (Pseudechis australis), *yielding large quantities of venom.*

its lair in the grass ; actually he had speared a Taipan, which succeeded in biting him and also several of his dogs. He died the same evening. A dog, bitten by one of the specimens that we later captured alive, died in a shorty time, and exhibited, on autopsy, the most intense congestion of the lungs and other organs. The fangs of this snake are backwardly curved, almost viperine in form, and in a large specimen nearly half an inch long —very different from those of most other Australian venomous reptiles. The venom-yields of the Taipan are very large—400 milligrammes of dried venom being produced at a single bite. During the last expedition to North Queensland five specimens of this snake were secured alive in order that detailed observations on their biting habits and their venom-yields might be made in the field. The snake is a very dangerous one to handle and no native could be induced to assist. The colour of the eye — the iris of which is orange-red or blood-red —adds to the sinister appearance of this formidable snake. Fortunately it is nowhere very numerous but is found in greatest numbers where rats are abundant and dwelling in colonies, affording it always a plentiful food supply. Although the natives also eat these rodents they never visit the grass plains on which the large colonies of rats are found until the long grass is dry enough to be burned, such is their fear of the Taipan.

Two or three other large venomous snakes are found in the same territory as the Taipan, the most numerous of which is the Black Whip Snake (*Demansia olivacea*). The term " whip " snake is employed universally in the Australian bush for a number of slender, rapidly moving, and elongated snakes of this genus. *Demansia olivacea* is generally black in colour, uniform or tinged with reddish or olive, with a conspicuous orange or reddish tip to its tail. Although its movements are very rapid and it bites savagely when handled, it yields only a relatively small amount of venom (as do all the known snakes of this genus, e.g. : *D. textilis* and *D. nuchalis*), but its poison is not very toxic to man.

The grasslands or savannahs of the Peninsula are also

inhabited by *Pseudechis australis*—known in Queensland as the Mulga Snake—one of the " Black " Snake group, although copper-brown or olive in colour. It attains a very large size and great girth, specimens of seven or eight feet being not uncommon. It is a fighting snake and is extremely powerful and aggressive. A specimen that was captured for the extraction of venom was almost too strong to hold, and if it had succeeded in obtaining a grip of one's arm with a coil or two of its body, would have been capable of wrenching its head away. Its venom, fortunately, does not approach in potency that of the Taipan, and it is not nearly as dangerous as that reptile. One of the specimens on which experiments were made in the field produced, in 16 weeks, 3.2 grammes of dried venom, and, although the venom was extracted each week, towards the end of the series it yielded more than 300 milligrammes of dried venom at a single " milking."

How Snakes are " Milked."

Many of the snakes captured during the expedition were in captivity for periods varying from a few days to several weeks or months, and for this purpose a series of specially designed cages were constructed and screwed together in the field. The extraction of snake venom, or, as it is generally called, the " milking " of snakes, was carried out not only when snakes were captured, but at regular intervals subsequently, with the object of ascertaining the maximum and average yields over long periods, and also the rapidity with which venom could be secreted, as well as the physiological factors affecting its secretion. In the extraction of venom the snake was induced to bite the top of a glass vessel over which a rubber dam, such as is used by dentists, had been tightly stretched. The fangs alone penetrated the rubber dam, so that the venom ran down the inside of the glass and was thus collected free from saliva and impurities. Venom may be colourless, light or dark yellow, or pink in colour, but colour appears to have no significance, and it varies from time to time. When dried, in a specially constructed field desiccator, the snake venom assumes a pseudo-crystalline form ; it dissolves readily in water or in saline solution, in which form it is used for laboratory purposes. After exposure for several days over a powerful dehydrating agent the venom was stored in sealed tubes for future research on its physiological properties. At the present time the venom and venom-yields of comparatively few Australian snakes have been investigated, so that when handling species in the field of which nothing is known considerable care must be exercised—a precaution the importance of which was fully appreciated and scrupulously observed after our experience with the justly dreaded Taipan !

Sound and Noise.

A LECTURE on " Sound and Noise " was given at the Royal Institution last month, under the auspices of the Institution and the British Science Guild, by Dr. G. W. C. Kaye, Superintendent of the Physics Department at the National Physical Laboratory. The lecture affords an interesting comment on Dr. Hughes's article in *Discovery* (December, 1934, p. 345).

Dr. Kaye remarked that the study of sound, which not many years ago was mainly of academic interest, had laid the foundations of present-day acoustical industries of world-wide importance. Side by side had come the growth of noise to which many inhabitants, particularly of large cities, were being subjected, though in only a few countries was the problem of its mitigation being tackled scientifically. It was unfortunate that Nature had embedded the ear in a mass of sound-conducting bone so that hearing was the only one of the five senses which could not be effectively defended.

By comparison with many sounds, the human voice was very weak, and even during shouting the output was only about $\frac{1}{1000}$ watt. Suitably equipped, an orchestra of 75 had a normal acoustic output of about $\frac{1}{2}$ watt, which in strident passages might be increased 100-fold—quite enough, if it could be so applied, to light an average electric lamp. In the event of the drivers of all the motor vehicles in greater London taking it into their heads to sound their horns together, the total acoustical output of the simultaneous blast would probably be of the order of 200 horse-power—that is, more than enough to drive a London bus at full speed.

Many present-day building structures were effective conductors of sound and vibration. Some impact sounds only lost 1 decibel of intensity in about 1,000 yards of steel. In the case of single homogeneous walls one could forecast the insulation against sounds arriving by air, since it was wholly a matter of weight. The last line of defence against noise in a building was the use of surface absorbents. Ordinary hard plaster was a better reflector of sound than a mirror was of light, so that in modern rooms which were designedly free from curtains, upholstery and carpets, the noise level might become uncomfortably high unless one of the commercially available acoustic absorbents was applied to the walls or ceilings. These absorbents, which could be got to simulate almost any finish, were also valuable for correcting bad acoustics of concert halls, etc.

The new acoustics laboratory at the National Physical Laboratory had greatly facilitated investigatory work on the steps required to reduce sources of noise, on the noise proofing of walls and on the noise absorption of building and other materials.

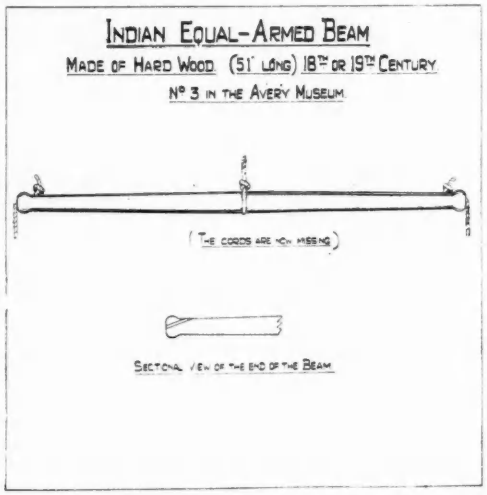
The History of the Balance.

By W. A. Benton.

Chief of the Research Department of Messrs. W. & T. Avery, Limited.

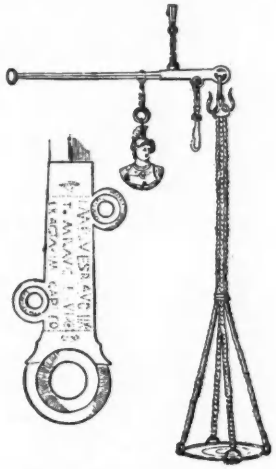
Like many other everyday objects, the balance or weighing machine has a long and interesting history. The Research Department of Messrs. W. & T. Avery, Limited, has made some interesting discoveries concerning the development of the art of weighing, and their historical museum at Birmingham contains many curious old machines, pictures, and models, some of which we are privileged to illustrate here.

ALTHOUGH the origin of weighing is unknown, it is certain that it goes back into the remote past. Before even the crudest instrument was devised to effect a balance or to weigh goods against a standard of weight the process of "hefting," i.e., lifting an object to estimate its weight, was in use. Often the goods were lifted by one hand and a weight by the other and then the two were changed about so as to render a rough comparison possible. Even to this day the peasantry in the remote districts of several European countries are content at times to buy and sell goods by some such rough method of manual weighing. There is evidence that balances of a comparatively fine degree of precision were in use in Egypt thousands of years B.C. These Egyptian balances were of the cord-pivot type, no knife-edges or pins being used. The beam was suspended at the centre by a cord attached to a bracket projecting from a massive standard, from which also depended a plumb-line. A downward-pointing tongue



A teak balance of simple construction.

attached to the centre of the beam, in proximity to the plumb-line, showed whether the balance beam was horizontal or not during the act of weighing. The end pivots consisted of cords issuing from holes pierced longitudinally in the ends of the beams and connecting with holes drilled from the top surface of the beam.



A typical Roman steelyard or unequal-armed balance.

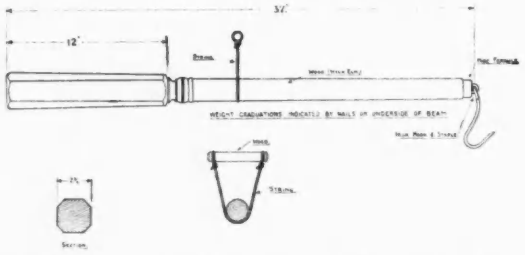
The ends of the cords issuing from the top surface were knotted or otherwise secured. The manner of construction is clearly indicated in the figure of an Indian beam made of teak, preserved in the Avery Historical Museum at Birmingham. Some of the Egyptian balances were of great beauty and, especially if they were intended for use in the temples, were constructed of costly materials. In some instances the beams and also the standards were made of electrum—an alloy of silver and gold.

The usual commercial instrument of the Romans was the steelyard or *statera*. This was an unequal-armed balance—the forerunner of the type long used by butchers and in other trades where bulky articles must be easily suspended. The Roman steelyard differs from the so-called "Danish" type—the commercial use of which is no longer permitted in this country—in that it can be constructed so as to possess a high degree of accuracy. In only a few Classical instances, however, is there evidence of an approach to the true knife-edge

in the construction of these instruments. In one *statera* in the British Museum, and in another in the Scottish National Museum, pins fixed in the beam are used for fulcra. The Romans never appear to have applied this great improvement to the construction of their balances. Generally speaking, both load hook and fulcrum consisted of ring-bearings. Thus the ring to which the load is attached is formed by making a round hole with bevelled edges in the end of the beam. The hook of the load-pan suspension is inserted in this hole, the hook being bevelled so as to form some approach to a knife-edge. It will be noticed that the hook is not precisely positioned in respect of the fulcrum, and that it might occupy a position a little nearer or a little further from the fulcrum. This would affect the weighings.

In several examples there are two centres of suspension for the load, one much nearer the fulcrum than the other, generally at exactly half the distance. Heavy loads were suspended from this inner ring, which in effect doubles the capacity of the instrument for the same movable poise and "long arm." A precisely similar device has been used in recent times. Two or more sets of numbers indicating weights could be engraved on different sides of the long arm, so that the weight of the load could be immediately determined. The Chinese are said to have used the same device at an early period.

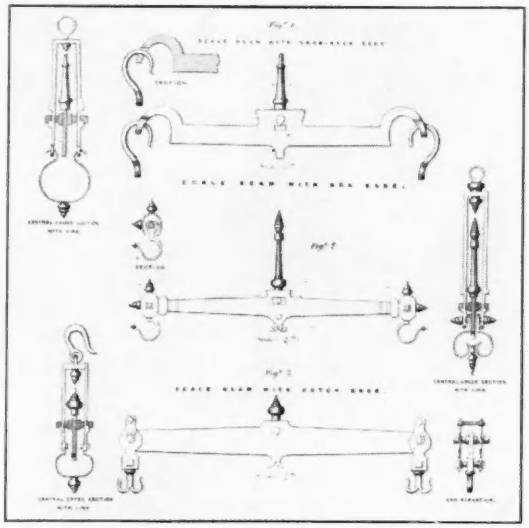
The question of the extent to which the Romans also used the equal-armed beam has been much debated, but the discovery of the ancient Pompeian painting known as the *Amorini Metallurgici* affords definite proof that they did use the balance for weighing costly materials.



A bismar, or Scandinavian wooden steelyard, from the Shetlands, the ancestor of the Orkney pundler.

Among other apparatus the artist has depicted two examples of equal-armed balances for weighing precious metals.

The Danish type of steelyard was probably introduced into this country by the Danes during the 9th or 10th century, but may have been used by the early Anglo-Saxon invaders. In this type the fulcrum is moved while the load is applied at the end of the lighter arm of the beam. The beam is permanently counterbalanced at the end opposite to the load-pivot. Until a few years ago this instrument was in use among the peasantry of the Shetlands, and it has been used in one form or another over the greater part of Europe and Asia. Accumulating evidence suggests that this type is of Eastern origin, and was first developed in Central Asia among carriers and merchants. Its use in the East is still general, and among the Norwegian farmers of remote districts it is the instrument for weighing farm produce. A very large pundler, or wooden steelyard, of Roman type, from the Orkneys has been recently acquired by the Avery Museum and exhibited complete with its 31-lb. stone poise. This specimen, which is, as far as is known, the largest complete pundler on exhibition, bears a branded stamp, the royal cypher of George III; but three other earlier brandings have been obliterated. While the date of origin cannot now be



Swan-neck (top), box-ended (centre) and Dutch-ended beam balances, with their cross-sections.

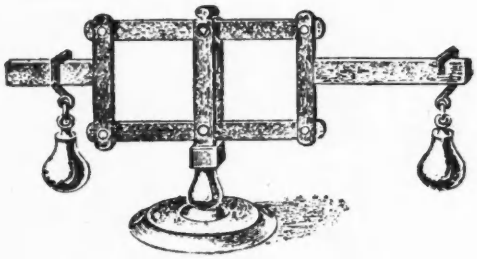
definitely ascertained there are indications which suggest that it is not less than three hundred years old.

The small fine balance beam used for weighing drugs and jewellery follows a line of development comparatively easy to trace, yet the steps by which the modern commercial beam reached its present accuracy are not so clear, especially in the early stages of its evolution. The first clearly-defined form fitted with knife-edges capable of definitely locating the suspension centres is that which for many years has been known as the "swan-neck" beam, illustrated herewith, although some evidence has recently been discovered of the existence

of an intermediate form towards the close of the Middle Ages. The section of the beam end shows that a true knife-edge location was obtained. The adjustment of these beams was generally effected by bending the swan-necks in or out so as to alter the arm lengths. With this type of end knife-edge no friction plates were required for the pan suspensions because each hook was located by finding a bearing at the bottom of the hole made in the swan-neck. The sharpened outside bottom edge of this hole constitutes the knife-edge proper. The peculiar form of the ends of the beam does not make for permanent accuracy of adjustment, and any overloading is likely to result in a shortening of the arm lengths. The use of swan-neck beams for many purposes is no longer permitted in this country, but they are still made here in large quantities for export.

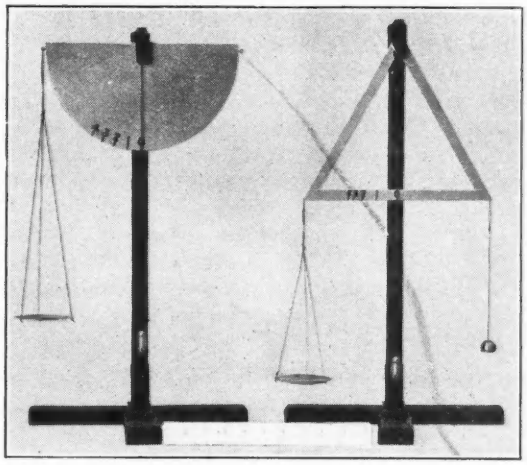
The introduction of box-ended and Dutch-ended beams was of considerable importance. Both types have rendered excellent service. The Dutch-ended beam in particular has long been noted for its commercial reliability, and various forms of this type have been in use on the Continent and in Eastern markets, as well as in this country, for at least two centuries. Another development was the construction of beams with continuous knife-edges and continuous knife-edge bearings such as are now used in all precision balances.

For commercial purposes it may be convenient to have the scale pans located above the beam, and free from the encumbrance due to suspension chains or crank rods. The first device to enable this to be done was invented about 1670 by Roberval, a French mathematician, though neither he nor his immediate successors turned this device into a weighing instrument. On account of its appearing at first to contradict the elementary rules of statics, it was termed a static enigma by the mathematicians of his time. In the illustration the linked



A "static enigma": the Roberval Balance, the forerunner of the modern counter machine.

portions will be seen to consist of two equal-armed beams, located one over the other, and joined at their extremities by two vertical links corresponding to the



Leonardo's pendulum-balances. Models constructed from his sketches by Avery's Research Department.

legs in counter machines of the Roberval type. These links and levers form a pair of parallelograms having a common side, namely the central support which carries the knife-edge fulcrum of the upper beam and round pivot of the lower beam. Unless the system is truly parallel it will not function.

The so-called enigma consists in this: that if the two poises are made to balance each other so that the beams are horizontal, a balance will continue to be maintained even if one of the poises is pushed towards the centre and the other removed from it. Many years after its invention this device was applied to give the convenient and accurate form of balance now popularly known as a counter-machine. A modern form of Roberval balance is the "Imperial" scale favoured by butchers.

A famous substitute for the Roberval system in counter weighing machines is the compound lever instrument of Béranger—a French scalemaker who took out an English patent in 1849. In this balance both scale pans are supported on pillars fixed to cradles which depend from the weighing levers and are contained in the casing which protects the whole of the mechanism from dust and the possibility of derangement. At one time four pillars arose from each cradle, but in the latest type only one substantial pillar is used for each pan. This mechanism is suitable for only small angular movements, and is seen at its best when weighing with the main beam horizontal as in ordinary counter scales. By skilful designing it has, however, been adapted for use in semi-automatic balances of remarkable sensitivity.

As commerce developed during the Middle Ages the necessity of a machine capable of weighing heavy loads

became pronounced. Very large equal-armed beams were used in Dutch ports, and probably also in London. Such instruments involved the handling of heavy and numerous weights. To reduce this costly labour the Roman steelyard was taken up and developed, and instruments of very large capacities were eventually constructed. Elaborate arrangements of pulleys and rack-and-pinion gearing were devised to enable heavy loads to be lifted and suspended from such steelyards.

A great advance in the construction of machines for weighing heavy loads was initiated by a Birmingham man—John Wyatt—a pioneer in many realms of invention, and one of the original minds of the 18th century. After being practically ruined in a long struggle to achieve success with a spinning engine, he entered the service of Matthew Boulton many years before the latter erected his famous Soho Foundry, now occupied by Avery's. Whilst with Boulton he developed the compound lever weighbridge, similar in essential principles to the standard weighbridge of to-day. Two triangular second-order levers were placed one at each end of the bridge, and stools projected from the platform and rested on pivots attached to these levers. The long arm of each lever was connected to the short arm of a third lever—a simple first-order lever, the fulcrum of which rested on a pedestal. Since both the triangular levers had the same "power" or leverage, the effect of the load was the same no matter where it rested on the bridge. The long arm of the transfer lever terminated in a small table on which weights could be deposited to balance the load. The long end of the lever would naturally rise when the load was deposited on the bridge. Hence, this type of mechanism has come to be known as the "bob-up" type. Some small platform machines are still made on this principle, but the weight-carrying table is now properly suspended from a knife-edge on the end of the long arm of the transfer lever. Platform machines of the latest type have been made to weigh up to 150 tons and more.

Leonardo the Universal.

A type of weighing mechanism which will weigh goods without the use of weights or without moving a poise along a steelyard is known as a self-indicating weighing instrument. The inventor of this popular type of mechanism was Leonardo da Vinci, mathematician and scientist. This convenient method of automatic weighing by means of a pendulum or bent lever has since been greatly developed, and is now applied to numerous types of machines, some of which will weigh up to 50 tons. It is also the principle underlying most modern self-indicating counter machines.

A Record of Progress in Printing

Penrose's Annual (Lund, Humphries & Co., Bradford; 8s.) is this year not only, as it always is, a wonderful collection of specimens of fine printing in colour and in black and white by a great variety of processes and on a great variety of papers, but it is also a sort of cyclopædia of interesting facts relating to printing and to many other matters with which printers are more or less concerned. Most of us have seen during the past year remarkable photographs taken with infra-red plates. The average person accepts them as one of the miracles of modern science, assuming that views showing clear detail of objects forty or fifty miles from the camera must be obtained by some instrument quite outside the range of the ordinary amateur. And yet the idea which the process involves is to be found in an object in quite common use, the orange filters which we use for motor car headlights in foggy weather. This is one little item of information gathered from the long series of articles by experts which precedes the plates in the volume. This comes from "Notes on Recent Infra-Red Work," by Olaf Bloch, the head of the Research Laboratories of Ilford, Ltd. Here is another item, this time from "Postage Stamp Printing by the Photogravure Process" by B. Guy Harrison. Every day we are tearing postage stamps from perforated sheets and sticking them on our letters without a thought for the difficulties of the process of manufacture which make the whole thing so very easy for the user. "Apart from the fact that it is necessary to produce from one hundred to two hundred and fifty images on one sheet, all exactly similar in impression and design, and frequently many millions of sheets all precisely similar to each other, the printer's task is complicated by the subsequent operation of perforation. In certain instances this would be a comparatively simple matter if the manufacturer were dealing with ungummed paper. As, however, gum is of a hygroscopic nature, it causes the sheet to expand or contract, in accordance with the amount of moisture absorbed or evaporated. The ideal method, in order to obtain complete accuracy in perforating, is to perform this immediately after printing, on a combined printing and perforating machine; the latter process, however, is usually a slower one than that of printing, and if the two steps are combined they involve a considerable reduction in output."

Another article describes a new hand camera which takes instantaneously in one exposure the three negatives required for colour photography. The *Annual* certainly ought to be read by all who are associated with printing, but the more general reader also will find very much in it that is attractive.

Man and Mosquito in Ceylon.

By S. Vere Pearson, M.D., M.R.C.P.

For some time it has been widely recognised that malaria caused the decline of Greece and Rome ; but, as Dr. Vere Pearson indicates, the malaria may have been first given a foothold by lawless conditions. Ceylon has suffered a similar decline ; the question is whether we are not to-day hampering recovery rather than helping towards it.

ONLY in recent years has it become clear in what ways and to what extent populations have varied according to the prevalence of malaria. In Ceylon, for example, many authorities believe there was a bigger population some centuries B.C. than there is in that island to-day. Its distribution was, at any rate, quite different from that of the present. The dry northern regions, where malaria now devastates the inhabitants and miserable poverty reigns, were once upon a time well irrigated and thickly populated. The wet regions where the rain of the S.W. monsoons fall, which are now the most thickly populated and productive of most of the wealth, were but sparsely populated in olden times. The island of Ceylon has a very variable rainfall. In some parts, the more central and highest (now possessing a fairly thick population cultivating tea, coffee, and rubber), it rises to 250 inches per annum. In these districts to-day the spleen rate, indicating the incidence of malaria amongst the inhabitants, is very low. In other parts, mostly in those situated at a low altitude above sea level, and mostly in the north and east of the island, the rainfall is but a few inches, or at most 20 to 25 inches per annum. These drier parts have to-day a very high spleen rate, yet in ancient times they were not only the most thickly populated districts but also the most prosperous, as ancient inscriptions and ruins prove. The reasons why these changes of population distribution have occurred depend upon influences connected with ancient methods of irrigation and other factors which have only recently come to be understood. Irrigation affects agrarian systems, property rights, and mosquito breeding, all of which affect the growth and aggregation of populations. The work of Sir Malcolm Watson and others has shown that wars depleted populous districts and led to underuse of water from the irrigation "tanks." This resulted in the multiplication of dangerous mosquitos, causing endemic ague.

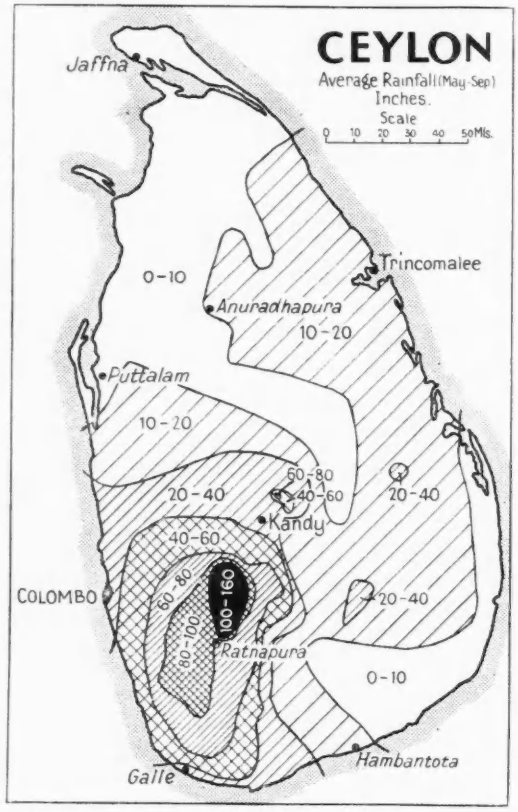
Anuradhapura, the ruined capital of an ague-stricken empire.

When man discovers how to get more food by better agriculture or by better methods of transport, a denser population can be supported on a given area. These two conditions, better agriculture and accessibility, influence taxation and land tenure and are influenced by these things. Methods of irrigation have much to do with assessments of rents and the public services rendered in return for those rents. Depopulation will occur when taxation oppresses, when assessments are badly arranged, when autocrats (kings or governments) impose arbitrary and burdensome methods of raising revenues or when they use the revenues collected for evil and subversive purposes, and when, through any of these causes, disease spreads. This especially applies to malaria. In Ceylon in the age starting three or four hundred years B.C. and ending about a thousand years later vast resources were spent on wars.

Wars affect populations in various ways—always adversely. Even when war spreads disease the effects come about in a variety of different ways, and this is so in regard to the disease malaria. For example, if the number of infected persons introduced from outside a neighbourhood remains small, malaria will fail to make headway and die out ; and this kind of thing may continue for years or perhaps centuries. But if the number of infected immigrants is suddenly greatly increased, as may occur in war, then much larger numbers of mosquitos may become infected, and may in their turn infect more healthy people than the recovery rate will compensate for (see W. H. S. JONES, *Malaria and Greek History*, p. vi). But it was in no way of that sort that

war brought about wholesale depopulation of ancient Ceylon.

The history of Ceylon in ancient times, under its Sinhalese kings, is mainly a chronicle of royal crimes, virtues, and delinquencies; of the long drawn out struggle with invading princes and armies from Southern India; and of internecine strife. The civil wars involved family connections in India and were thus not confined to Ceylon alone or to the Sinhalese. They were the exception rather than the rule after any long and successful reign. Probably a peace-loving prosperous population was compelled by ambitious princes to abandon their agriculture in the fertile areas under cleverly planned irrigation and to join in wars from which many of them never returned. One reason why wars were common and very possibly fierce was because polygamy gave rulers many sons who wanted power. Rulers could command a following irrespective of the justice of their cause because land was held on a service tenure. The feudal lord would call upon his tenants to follow his flag. Not only did people suffer directly but also through interference, as an ordinary tactic of warfare, with the wonderful irrigation system which had been built up. The tanks and channels suffered much damage.

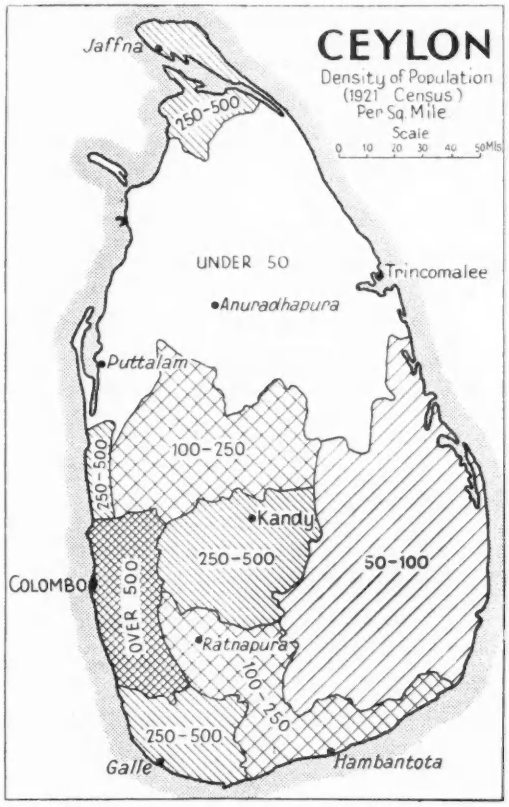


The dry north part of the island, now mosquito-ridden and scantily peopled, was the centre of ancient prosperity.

Now to understand how these things led to widespread malaria and permanent depopulation it is necessary to enter into some of the details of the life of the malarial parasite and of its other host, the anopheles mosquito, and to learn the connection between these things and irrigation. It used to be thought twenty years ago that ague (an old-fashioned name for malaria) was kept down by dealing with stagnant pools of water where the anopheles larvæ throve and that the main thing to do was to drain swamps and pour oil on to the surface of the pools. But in more recent times it has been discovered that matters are not so simple as this. There are dangerous species of mosquitos in some districts which thrive in clear, slowly running water. Dirty water is bad for them. Hence mining operations, or the muddying of water through agricultural cultivation, through washing clothes, through refuse, or through the action of domestic animals, diminish malaria. Again, the action of shade over the water is of importance, and the presence of fish in certain circumstances. A good system of irrigation means tanks well filled with fish. It means clean channels along which the water can run briskly. That means no weeds or grass in the water on which the anopheles larvæ can hang and thrive. It also means inhabitants to cultivate the fields irrigated and render much of the shallowest water muddy. The fish in the tanks provide a protein diet to supplement the rice of the natives to keep them vigorous and healthy. Also the small fish feed upon the larvæ of the mosquitos and keep them down. The dangerous species of mosquito are found in the cultivated regions below the reservoirs, especially now that human beings dwell there in too small numbers to stir up and use the water. It is true that one authority, Dr. Lucius Nicholls, believes *Anopheles minimus* (a large group of mosquitos, mostly malaria carriers) must have been a new importation into Ceylon and that this explains a change from prosperity and dense population to an ague-devastated sparse one. But Sir Malcolm Watson, after years of study in Malaya, Assam, and Ceylon, does not agree with this view. He considers that this species never got a chance until there were not enough people to dirty the water, and that this state of affairs was

brought about through war. As long as there was a population surplus to the water and the water was thereby muddied, then there was no malaria. As long as conditions were normal there was never a water supply surplus to the population. People did not trouble to build a dam before it was wanted. But wars came and upset everything. Human beings were slain, or driven out, or taken away to fight in foreign parts, and the dangerous species of mosquito established themselves. Malaria found a foothold.

The conditions which favour the spread of malaria are not always the same. They vary according to the species of mosquito, and from one country to another. Field work in various tropical countries, religiously and laboriously carried out, has revealed the variability and the complexity of the life history of different species of mosquito. In this country one kind of mosquito is dangerous; in another, another. In one place hill streams are dangerous breeding grounds and rice swamps safe. In one place one kind of fish in certain circumstances helps to keep down mosquitos which carry the disease, in another, another kind. Here shade is inimical to the microscopic vegetable organisms which form the food of the dangerous mosquitos and its growth over streams drives them out. In Assam, as has been shown by Ramsay and Savage[1] the *Anopheles minimus* is almost the sole carrier of malaria. There much harm has been done by clearing jungle that was shading the clear and slowly running water in which this mosquito breeds in the absence of shade. But in Ceylon, in most parts of that island at all events, shade has little to do with the incidence of malaria.



Comparison with the map opposite shows that low population and low rainfall accompany each other nowadays.

For many centuries before the power of Lanka declined the Sinhalese rulers of old thought in terms of food-supply grown by their own people for their own needs. The whole of society was organised on that basis and the system of land tenure depended upon it. Hill streams were tapped and their water guided into the giant storage-tanks below, some of them four thousand acres in extent, and from those channels ran to other large, more remote reservoirs. These, with hundreds of subsidiaries, fed paddy fields and innumerable well peopled villages. All the evidence points to the fact that the ancient Sinhalese conquered and lived prosperously throughout nearly all the plains that are now so empty of men. The tank age endured for centuries. But wars and ague laid waste. The people perished. Poverty and depopulation became permanent.

It is interesting to reflect that the ancients in Ceylon somehow hit upon the means of prosperity and amongst them the means of holding malaria at bay. By painful experience and by laborious research we are to-day coming to know how to repair serious mistakes which affect populations adversely in several ways and in various places. Will the dry belt of Ceylon ever again be peopled as it was 2,000 years ago? Some authorities estimate there was at the very least five or six times as large a population in those regions as there is to-day. Will the tea-planters of Ceylon who have thriven in the wet zones during the last fifty years (they had hardly started fifty years ago) go on for centuries gaining wealth from the ground after denuding the land of forest? Nature's capital has consequently been flayed off by the rain. Will they not fail to prosper unless they learn something from of old and find the means of conserving the soil? Will not the

[1] G. C. Ramsay and J. de la M. Savage (B. M. J. 1932, ii, p. 790).

Two photographs, by Dr. Jacocks of the Rockefeller Institute, show the ancient irrigation system of Ceylon. Left, the Basawak Kulam tank at Anuradhapura (400 B.C.) *; right, the beginning of the Yodi Ela, a channel 53 miles long connecting the huge Kalawewa tank of over 4,000 acres with Anuradhapura* (A.D. 500).

restoration of the ancient system of irrigation and of certain age-long customs of land tenure and taxation not only banish poverty but also abolish, or at all events greatly reduce, malaria? We pride ourselves on having unravelled the causes of many diseases, and on having amassed much useful knowledge about sanitation, as well as about scientific agriculture and transportation. Much of this knowledge was quite unknown to the ancients. To-day adverse climatic conditions, the ravages of parasitic diseases, and the difficulties of providing an ample supply of food for all should no longer encumber us. Yet a lack of the necessities oppresses many peoples. Fresh knowledge is helping to lessen the terrible scourge of malaria in Ceylon. But that is not sufficient to bring new populations who are happy, healthy, and prosperous. Many people imagine, now that the world is smaller through freer communications, wider commerce, and greater knowledge, that populations will prosper wherever favourable circumstances exist. But man has lost sight of his dependence upon the earth. To-day in Ceylon, despite all the advances of modern progress, are to be found side by side, introduced from Europe, the private ownership of land, the plantation system, and some of the worst forms of taxes ever devised to harass production and trade. In ancient days the land was never allowed to become the private property of the few; and the collection of revenue for the agricultural and martial needs of the community, or for other public expenses, such as religious or state ceremonials, was based on an entirely different system from the taxation system of to-day. It was based on the value which the land had by virtue of its position and by the fertility acquired by irrigation. To-day private ownership of land is permitted, and a distorted view is held about the rights of property, communal and individual. Consequently poverty persists and populations become maldistributed. Rural districts are depopulated and the cities overcrowded. The world's secondary industries become unduly filled and hordes of "tax-eaters" and "bureaucrats" arise. The ancients, despite their limited knowledge, exhibited more wisdom than we do in the present generation. Calamities came only when their wise systems were departed from. Then disease and depopulation occurred and sometimes even complete civilisations disappeared.

Thunderstorm Survey.

THE recently published *Third Annual Report on the Survey of Thunderstorms in the British Isles* (Thunderstorm Census Organisation, Huddersfield. *2s. 6d.*), based on the work of about 1,200 observers, contains a set of maps showing the monthly and seasonal distribution of thunder in the summer of 1932. The prevalence of summer thunder in East Anglia and in the Midlands is again indicated. This is in sharp contrast to the stormy areas on the west coasts of Scotland and Ireland suggested by the winter storm survey. A synopsis of later results for the summer of 1933 suggests that although thunder occurred on as many as 103 days out of 183, storms were not as frequent as in either 1932 or 1931.

The results of the survey of trees struck by lightning suggest that the elm and the oak are most commonly visited. Examples of damage include pictures of right hand and left hand spiral strokes. A section on the progress of a lightning flash includes photographs by means of a Boys camera showing the component strokes.

The annual census of thunderstorms will be continued as from April 1st, 1935. The assistance of observers will again be very much appreciated. More records are particularly required from moorland and rural areas and from thinly populated districts generally. Records should be sent to S. Morris Bower, Langley Terrace, Oakes, Huddersfield, from whom observation cards and fuller particulars may be obtained.

Selection Tests for Colour Workers.

By A. Hudson Davies.

The writer of this article was for some years a member of the staff of the National Institute of Industrial Psychology, and devised the test for the selection of colour workers which is described below. In modern industry such tests are of growing importance and are worth careful study.

WHILE industry was young, its tasks were relatively simple, and the need for the careful selection and training of its personnel was unrecognised. A worker was tried in a job, and if not suited to it, was moved or dismissed. Even to-day, over the greater part of the employment field the marriage of person and job is still haphazard, and a worker may try or be tried in job after job before he finds the niche for which his abilities most fit him, or else sinks into the unskilled, undifferentiated majority.

Yet the factors which increase *per capita* production —specialisation, the use of power, the application of science—create also an increasing demand for special abilities in the worker. Realisation of the importance of adjusting men to jobs is now growing, and is leading to a widespread search for methods of choosing workers, and of advising new entrants to industry which will avoid the expense of spirit, time, and material chargeable to the old method of selection by trial and error.

A Guide to the best Workers.

Already we can measure some of the many special personal abilities of men by reasonably simple tests. Obviously, no one of experience will claim that the results of such tests can safely be used alone to predict the success of an individual in a particular job. But when they are considered in conjunction with such other factors as physique, health, education, temperament, they give very positive help in the choice of workers most suited to many jobs, and by themselves can often be used to eliminate probable failures.

The National Institute of Industrial Psychology has been active for some years in this country in the development of such tests and the present notice is prompted by the appearance of a small book* which summarises one of the most sustained researches in vocational selection which has yet been undertaken. Arising out of the directly felt need of a printing firm, an investigation of methods of choosing colour workers was begun. A possible and promising test has now been worked out. In general form the construction of this test has been so typical of the progress of all researches on selection tests, that some discussion in these columns is worth while.

In 1926 a firm of colour printers asked the Institute for help in selecting workers for positions on the process side. They had found that the lack of a scientific method of choice had led to occasional, but costly mistakes. One of the chief responsibilities of a machine operator in printing is the matching of the colours printed by his machine against samples which have been approved by the customer. Colour blindness tests (such as the Edridge Green or Stilling tests) are not of much use in choosing men for this work because the chances are all against the survival in a printing works of anyone with a serious degree of colour-confusion. One colour-defective was actually found in this firm, but his defect was rare and subtle, and in any case he was an apprentice who had not so far carried solitary responsibility.

It is not the mistaking of green for red which costs money, for this does not happen, but rather the temporary confusion of close shades which may cursorily be judged to be the same, but which, on leisurely examination in a proper light, can clearly be seen to be different.

Although the operator has a sample to which he can make a match, local conditions often make his task difficult. The lighting in printing works is sometimes not as good as it should be, in quantity or quality. Daylight of varying quality, and electric light are used at different times, even though it is known that colours which match under daylight may not do so under electric light. The adoption of constant artificial daylight lamps for matching purposes makes only slow headway.

A highly-skilled Job.

Some difficulties are avoidable, but most are inherent in the job. It is frequently necessary to judge whether a machine is properly set by the appearance of a wet sample which will dry several shades lighter. The operator must discount this alteration in judging whether, when dry, his sample will match the customer's. If he thinks it will not, he must decide whether to alter the colour of the ink, its consistency, the rate of ink-feed, or the heaviness of the impression, or all of these. If the paper is rough he must reckon on some dilution of his colour with white, because the ink cannot be forced into the valleys of the paper, and so on. He may want

**The Selection of Colour Workers.* By W. O'D. PIERCE. (Pitman. 5s.)

a grey or lilac impression, but the ink he mixes is deep purple. If he prints a yellow centre in a red label, and matches the first yellow printing against a complete sample, he must remember to allow for the effect of contrast when the red printing is put round the yellow centre. The yellow which by itself would appear to the layman a good match to the yellow of the sample, is as likely as not to be obviously wrong when printed with the final red surround.

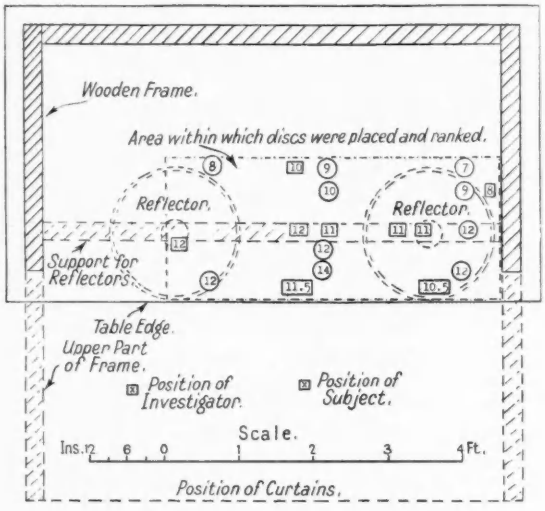
The operator must be correct and rapid in such judgments. If he is slow the output of very expensive machines may be delayed. If he blunders a whole printing may be rejected by the customer with a loss not only of material, but also of goodwill. In dyeing, paint manufacture, in the paper and textile industries there are similar responsibilities and similar complications. Experience is an essential element in success. But also, it is clear, an unusual quickness and acuity of colour discrimination is necessary in the colour operative. It was for this special ability that a rapid test was required.

There are a number of limitations in the form of an industrial selection test. It must not be too complicated nor need too highly trained an observer. It must not take too long, nor involve cumbersome and costly apparatus. The subject must feel free from constraint—the more nearly the test resembles the conditions of normal work the better. The test must be simple enough, and specific enough for the subject to be unable to make up by intelligence what he lacks in the special ability which the test is designed to measure. There must be a way of expressing success or failure by a numerical score.

A number of excellent scientific instruments for the testing of colour vision are ruled out by one or other of these limitations, and the idea gradually evolved of a test in which the subject would be presented, under standard lighting conditions, with a series of coloured surfaces which he could handle and compare with something of the freedom of normal life. This idea was easier to conceive than to realise. Printing, dyeing, the mixing of powdered colours dry and in gelatine, all proved to produce untrustworthy results. Such slight step differences as were demanded, could not with certainty be made. It was only after long search that an inspiration from the methods of quantitative chemical analysis solved the problem of preparing a series of discs in which there was a progressive, but almost imperceptible change of colour.

By the new method three series of discs were made—blue, yellow, red corresponding roughly to the colours used in three-colour printing. Each series consisted of sixteen discs in which there was a continuous change from one end of the series to the other, the variation consisting in the step by step addition of minute quantities of white.

Under test the subject is presented with the red series all mixed up, and is asked to sort them out into



Plan of testing room. The numbers indicate the illumination in "lumens" (candles per sq. foot).

their true order with the darkest on the left. A light of constant intensity and colour is used in the testing room so that the conditions are the same for all. After the red series, the blue and yellow series are successively given.

At first sight almost everyone thinks the task of sorting the discs is hopeless, for the shades are very close, but gradually they begin to be distinguished, and, on the average, each series is sorted in about ten minutes. The scoring is done by counting the total misplacings—the more accurate the performance, the lower is the score.

Example:

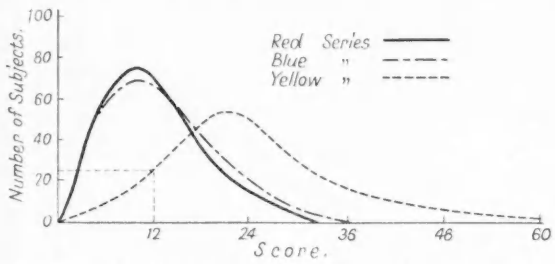
Actual order ..	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Test result ..	2	1	4	6	3	5	10	7	8	9	14	13	12	11	16	15
Place errors ..	1	1	1	2	2	1	3	1	1	1	3	1	1	3	1	1

Score—Total errors 24.

The errors made by a very large number of subjects varied from 12 (for all three series) to 142—a very wide and well marked variation. Typical curves of error are shown in the diagram which follows.

The colours of these discs were so close together that until very recently no instrument has been capable of measuring the small differences automatically. Measurement by instruments depending on the judgment of the eye was not permissible, for the eye of an observer has no greater authority than his own ability in colour dis-

crimination gives him. How then are we to know that these discs have come out of the manufacturing process with their small differences (too small to be discriminated with certainty by anyone), running step by step in



Frequency distribution of scores by 297 subjects. Example: 25 subjects made 12 mistakes in the Yellow series. The Yellow series gives an unexpectedly wide "spread" between the best, average and worst scores.

the order we intend? After experiencing the difficulties of manufacture it was expected that there would be inaccuracies. How could these be found and rectified?

The answer is that by combining the placings of all who try the test, a kind of mass vote for the accuracy or inaccuracy of the series can be built up. This check was applied after 171 subjects had taken the test, and again after 336 subjects. The average positions given to each disc were worked out. The table shows the results for the red series.

Original Disc number ..	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Average placing	2.0	2.5	3.8	4.5	5.5	8.0	9.5	10.0	9.7	9.7	9.9	11.1	10.9	12.6	12.5	13.9
True rank	1	2	3	4	5	6	7	11	8.5	8.5	10	13	12	15	14	16

It is clear that the supposed order of the discs is wrong. 9 and 10 are the same, 8 should be called 11, and so on. Small differences in mixing or in drying the colours have caused variation. But now we have found what is probably the true order, especially since the average position given by the first 171 subjects tallied closely with the averages given by 336 subjects. And though we have been unjust in our early scoring to the man who transposed numbers 14 and 15, debiting him with two mistakes, now that we know he was right after all we can quite easily go back and correct his score by the true order.

The Second Step.

It would take too long to follow the detailed argument of Mr. Pierce's book which is, however commended to those who are interested in statistical analysis, for by the use of comparatively simple methods of attack it has been possible to reveal objective differences too fine for any instrument to detect and not only to reveal them but also to measure them.

The most anxious moment in the design of a selection test now comes. If we take a group of workers, some of whom are known to be good at the job, and some not so good, can the new test sort them into their correct relative order? Their scores under test are arranged in order and compared with an order of ability which is based either on the quality or quantity of their output, or on the judgment of foremen or managers who know their work well. Between these two orders a coefficient of correlation is found. If the orders are identical the coefficient will be + 1.0. If they have no relation at all the coefficient will be zero. In the first trials of a new test, figures of 0.5 to 0.6 are encouraging.

Mr. Pierce succeeded in the not too easy task of finding a large coherent group of workers whose ability could be independently assessed. These people were "pirn sorters" in the artificial silk industry. In the batch dyeing of silk it is impossible to obtain absolutely uniform dyeing of the hanks or pirns. Some dye lighter or darker than others. The differences are almost imperceptible in the hank, but may become very obvious when the hanks are woven into fabric and threads from two different hanks are juxtaposed. The job of the "pirn sorters" is to grade the hanks so that such blemishes are avoided. Thousands of pirns are sorted each day, and it is found that only the human eye is quick enough and accurate enough for the work.

A group of twenty sorters were tested, and also ranked independently by a foreman and a forewoman. Between these orders the following correlations were obtained:

Test order and foreman's order	0.51
Test order and forewoman's order	0.69
Test order and foreman and forewoman's orders combined	0.87

—results which show that the test on the whole correctly discovers which are the best pirn sorters.

Other evidence of the selection value of the test is provided by comparisons of the *average* scores of groups of differing experience or ability, and Mr. Pierce adduces a number of results of the following general form:

Type of Worker.	*Number in Group.*	*Average Age.*	*Average Experience.*	*Average Score.* (Mistakes.)
Highly skilled silk sorters	6	21.0 years	4.5 years	30.0
Unskilled silk sorters	10	19.9 years	1.2 years	63.0

Not all the differences were found to be statistically significant, but over a selection of groups drawn from art schools, the cotton and wool dyeing industries and

the photographic industries, it is possible to conclude that the better the worker the lower in general is his score in the test, that is, the fewer mistakes he makes.

Testing the Inexperienced.

Now from the picking out of skilled and experienced workers in a mixed group, to the prediction of eventual success in untrained and untried workers is a long step. Among the untrained, individual scores as low as the lowest among the skilled workers were found, although the group averages were, of course, higher. But only time will show whether these young untrained low-scorers will ultimately prove to be the most successful in jobs requiring colour discrimination. It is almost certain that they will : but after all, to take the simplest case, we cannot be quite certain that the tall boy of fourteen will be a tall man at thirty. The possibility of predicting ultimate success will save much waste of hope and training, and the maximum value of the test will be realised if the test assists to make this practicable.

General Uses of the Tests.

It often happens, however, that, as in this case, industry need not wait for this proof before making use of the test. In many processes in the colour industries, extreme ability with colours is not needed until the higher levels of training and responsibility are reached. It then becomes important to select from those eligible for the key job, the workers who have as an essential qualification the highest ability in colour discrimination. This function it seems can be reliably performed by the new test.

The time has now come for more general application in the colour industries and for the working out of various special uses for the test. It is encouraging to see from the introduction to Mr. Pierce's book that several firms have already co-operated in this research, and it is understood that as a result of other enquiries several sets of test-discs are to be made to replace the eight-year old originals with which the present investigation was conducted.

The main purpose of this notice was, of course, to describe the preparation of this test for ability in colour discrimination as a particular case of the general methods used for preparing and checking selection tests for industrial workers. As in any good scientific work, there is no room for hurried or careless experiment ; nor room for the careless deductions which might lead to the suspicion of charlatanry. The interest of Mr. Pierce's book is in the first place for those concerned in the colour industry, but in the second, for all who are interested in the selection of industrial workers.

Correspondence

SCIENCE AND RELIGION.

To the Editor of DISCOVERY.

Sir,

A copy of the issue of *Discovery* for September, 1934, came into my hands yesterday, and my eye fell upon Professor Julian Huxley's questionnaire.

It is easy to frame a list of questions and to demand that they shall be answered by a simple Yes or No. But as a method of approach to a subject of importance it does not deserve to be taken very seriously. It may, however, be worth while to say one thing *à propos* of Professor Julian Huxley's questions.

Petitionary prayer is a hope couched in terms which physical science is not competent to criticise. These terms take into account factors which cannot be measured ; therefore physical science can never have anything to say about them. If it is intellectually legitimate to say during a period of drought " I hope we shall get some rain soon," it is at least equally legitimate to say with the Prayer Book " O God . . . send us, we beseech Thee, in this our necessity, such moderate rain and showers," . . . etc.

For anyone who believes that the ultimate reality is personal the Christian version of the hope is the more rational.

Yours faithfully,

R. H. MALDEN (Dean of Wells).

The Deanery,
Wells, Somerset.
5th December, 1934.

To the Editor of DISCOVERY.

Sir,

It is suggested that the following quotations provide the necessary " atmosphere " for a discussion of the questionnaire in your September number :—

1. From Mr. Gerald Barry, ". . . with all our vaunted intelligence we are very poor creatures, who use our brains only with the greatest difficulty, not a little lower than the angels so much as a little higher than the beasts."

2. From your correspondent from Australia, ". . . when scientists leave the impression that there is only one side : that unless science can discern God with apparatus, and bring Him up to the touchstone of scientific criteria He does not exist (or if He does exist, He is the bond-slave of His own mechanism), they are doing humanity a grave disservice."

I remember one of Mr. Rudyard Kipling's stories about the man who was brought up amongst bricks and mortar and the smell of asphalt, and believed that the engineers of the Metropolitan Board of Works made everything !

I suggest, not dogmatically or otherwise than with due humility, that mediæval ideas are fading away, if that is what Professor Huxley means to imply, and that as, all through the ages, it is an historical and scientific fact that the human mind eventually brings religion down to its own level—for instance, Jupiter, Zeus, Moloch and all the idols of the East, and now, in Europe, the Idol of the Mass Mind, so dangerous in the future, as recently pointed out by General Smuts at St. Andrews—that the greatest service Science can do for humanity is to cease apparent conflict with religion—I say " apparent " because there can be no such conflict,—recognise the historical and scientific fact that theology must be always a hundred years behind the times from its very nature, and, in the meantime, avoid such unscientific and false assumptions as that of Mr,

Kipling's hero. Surely, there is work enough to reveal the works of the Great and Glorious Being, the Great Architect of the Universe without going back to quarrel with the ancient ideas when there was no advance of Science to be so proud of.

Otherwise—and very humbly I turn to Geology only—the Dinosaurs are supposed to have existed on earth ten times longer than the human race. These reptiles are now extinct. It is a matter of opinion why they became extinct. In these days of poison gases are we, humans, likely to survive so long ?

One needs a trained lawyer at one's elbow to frame an answer to the questionnaire so that it safely represents one's view, so one's mode of thought has to be amplified.

Yours faithfully,

H. A. COLLINS.

Johannesburg, South Africa.
12th November, 1934.

To the Editor of DISCOVERY.

Sir,

Any answers received from your readers in reply to the questions proposed by Professor J. S. Huxley in your September issue will doubtless be of considerable interest. But I would suggest that they are unlikely to be more conclusive as evidence of what competent scientists think about religious matters than the replies from some two hundred Fellows of the Royal Society published by Messrs. Ernest Benn, Ltd. (editor, C. L. Drawbridge) in 1932 under the title of *The Religion of Scientists*.

The great majority of these replies to six separate queries was favourable to religious belief.

Yours faithfully,

L. RICHMOND WHEELER, M.Sc.

Butterworth, Province Wellesley,
Straits Settlements.

ASTRONOMY AND MODERN THOUGHT.

To the Editor of DISCOVERY.

Sir,

I have noted Mr. Eastgate's comments on my lecture reported in the October and November numbers of *Discovery*. With regard to his first criticism, I would say that of course I did not mean to suggest that Spencer was unaware of the existence of dissolution as well as of evolution in Nature. What I wished to emphasise was the broad contrast in outlook between the ideas prevalent in his day, when stress was particularly laid upon synthesis or development " from an indefinite, unstable homogeneity, to a definite stable heterogeneity " as the dominant factor in cosmical evolution, and those of the present time, when emphasis is laid rather on dissolution—the breaking up of atoms —and the increase of entropy. The real purport of my remarks is contained in the sentence " It looks as if, after all, we are not so very far wrong when we take the long view, in comparing the process of cosmical evolution to the traffic in a one-way street—only the movement is in the opposite direction to that which we were once wont to believe." However, I certainly have no desire whatever to belittle Spencer, and Mr. Eastgate's comments will serve a useful purpose in correcting any wrong impression I may have unintentionally given.

As regards the reference to *annihilation*, I may remark that this word is employed by Sir James Jeans of whose theory I was speaking. Mr. Eastgate, however, will note that my expression was " the actual annihilation of stellar atoms *as such*," i.e., as atoms—while I went on to refer to the conversion of the protons and electrons into radiant energy.

In reply to the last paragraph of Mr. Eastgate's letter, I need only say that although there is really nothing new in the sentence quoted from Sir James Jeans (I had referred in my lecture to Berkeley's idealism, and of course we may go back for kindred ideas at least to the time of Plato) yet it does illustrate the change in the views of many of our present day leading scientists as compared with the materialistic and mechanistic characteristics of 19th century scientific thought.

Yours faithfully,

THEODORE E. R. PHILLIPS.

Headley Rectory,
Epsom.
10th December, 1934

SUBJECTIVE AND OBJECTIVE REALITY.

To the Editor of DISCOVERY.

Sir,

The problem set by Mr. Blacktin in his letter in last month's issue is certainly an interesting one, calculated to send metaphysicians and others into a brown study for hours. While unable to give a definite opinion on the relationship between subjective and objective reality, I would suggest that the first part of the problem might be simplified as follows :

There is no stipulation as to how near the bottom edge of the glass sheet O_1 and O_2 may be, and so in the limiting case they can be precisely at the bottom ; thus there is no need for an observer travelling from O_1 to O_2 to describe any arc ; he can simply proceed straight across, at right angles to the glass surface. Again, there is no stipulation as to how thick the glass need be, and so in the limiting case it has no thickness, and it is not necessary for an observer proceeding from O_1 to O_2 to cover any distance. In other words, he simply stands still and turns through 180 degrees. But Mr. Blacktin states that " the observer at O_2 does not need to turn body or eye as a whole through any angle " ; he ignores the angle through which he must turn to catch the reflection from the mirror as it is only a pivoting movement and does not describe any arc. It has been shown above, however, that in the limiting case the other movement, that of proceeding from O_1 to O_2 and viewing the word direct, is, in the limiting case, also only a pivoting movement. Yet obviously this latter movement must be regarded, since it involves a change in relative position between the glass and the observer. If a concise statement of the difference between these two pivoting movements, which makes one negligible and the other important, could be arrived at, it might simplify a statement of the relation between subjective and objective reality.

Yours faithfully,

R. W. KIDNER.

Sidcup, Kent.
11th December, 1934.

A correspondent calls attention to a slip in the last line of Mr Fallaize's article, on p. 358 of our December issue. The stone circle referred to is on Stanton *Moor*, Derbyshire, and not at Stanton Drew, which is in Somerset.

Dr. L. E. C. Hughes writes to inform us that his article " Noise : a Perennial Problem," in our December number, has been filed by the Anti-Noise League in their Information Bureau for the use of their members.

Science and Religion.—II.

(A Reply to Professor Julian Huxley.)

By Alfred Noyes.

In this, the final section of his article, Dr. Noyes deals one by one with the questions set out by Professor Huxley in our September issue. Support for his reply is forthcoming, not from the theologians, but from the "materialists" of last century: Kelvin, T. H. Huxley, and Darwin himself.

I must recall here the words in which Spencer simply re-stated for modern scientific minds, without the slightest essential alteration, the primary conclusion of all the greatest religious thinkers of Christendom: "Though as knowledge approaches its culmination every unaccountable and seemingly supernatural fact is brought into the category of facts that are accountable or natural; yet, at the same time, *all accountable or natural facts are proved to be in their ultimate genesis unaccountable and supernatural.*"

The name we give to this ultimate Reality is of little moment. If you call it "matter" rather than "spirit," you run the risk of putting the cart before the horse, especially in these days when "matter" is dissolving under the scrutiny of science, and we are more and more clearly forced to believe that "the reality of an ordered world can only exist for mind, and in terms of mind." Indeed, as Voltaire suggests, in his Philosophical Dictionary, you may call the ultimate Reality "matter," if you like, and we will not trouble you to tell us exactly what you mean by "matter." We merely affirm that you will be forced, if you go deep enough, to endow what you call "matter" with the attributes of the very God whom you have rejected. It must be eternal and sufficient to its own existence; and this, in itself, is a mystery and an *antinomy* stupendous enough to fill the mind with awe. It must be capable of evolving ordered worlds and all the generations of men with all their art and literature and music, out of a cloud of hydrogen gas. It must be capable of shaping the hill called Calvary and of planting three crosses thereon. It must be capable of bringing into existence that Personality in whom the characteristics that we call divine were focused into definition for so many centuries. It must be capable of evolving the physical mechanism, the throat and lips, through which there may be uttered that superhuman personal claim, "I am the Resurrection and the Life." And this, as Aquinas might have said, is what we mean by God, and the Incarnation.

We have heard a great deal lately about the "curvature of space." Is there not something, and far more, to be said for the curvature of evolution? If it be true that we cannot get more out of the Source than the Source originally contained, and if it be also true that as human life and character develop to their highest and best we do get glimpses, however faint, of something that seems to belong to the eternal; if Socrates drinking the hemlock, and Kant pondering, with a sense of *das Heilige*, over the categorical imperative, seem a little nearer to God than the ape, is it altogether "uneducated" to think that they may indeed be on the return journey, towards what Plotinus called "the beloved Fatherland," and that the Word which issued thence, will of necessity be found there in its perfection?

It is on these grounds that I believe all Professor Julian Huxley's questions must be enlarged to include factors that he has ignored; and that they can be answered, all of them, in a very different way from that which he suggests.

"*Do you believe that God interferes with the natural course of events by performing miracles which are not explicable on ordinary scientific principles?*"

Read that question carefully, *in the light of what has already been said*, and it must be admitted that it is inadequate. The one, real, and eternal Being, described by Spencer as "supernatural" in its ultimate essence, can hardly be regarded as "interfering" with its own operations. There is a deeper aspect of the matter which includes both determinism and freedom and subordinates the machinery to the owner of the machine without destroying it or "interfering with the works." If we use the analogy of mechanism, we cannot escape the further analogy that all known machines, as Dr. Streeter so aptly reminds us, are created by mind, governed by mind and used for a purpose. Moreover, the more highly organised the machine, the more contingencies it is adapted to meet, not *against* the laws of its own structure, but actually *through* those laws. If there be any truth at all in the earlier suggestion that man does, at times, draw nearer to God, I see no reason why his prayers, in this way, should not be answered. But I do not think the analogy of mechanism adequate for the universe around us. It seems to me that the rational order which pervades it is more justly comparable to that of a great musical symphony, in which there is a more exquisite and subtle kind of mathematics, through which the spirit can also speak, and the influences of beauty flow into spiritual significance. "A

natural course of events" which depends entirely, for its existence, on a supernatural Reality, must be pervaded and directed in every act and atom by the influences of its inscrutable Source. Light is, perhaps, an even better analogy; for, as Galileo remarked, in one of the most profound and beautiful utterances ever made by a man of science, "*They are foolish who think that the vastness and complexity of the universe is an argument against the Providence of God in little things. The sun can ripen a bunch of grapes just as though it had nothing else in the world to do.*" The ultimate Power, omnipresent everywhere, is surely, in Wordsworth's phrase, "far more deeply interfused" than light.

"A motive and a spirit that impels
All thinking things, all objects of all thought."

If man, by obeying the laws of nature, can make use of them for ends that were otherwise unattainable, then —unless there be nothing higher than man in the universe (and this proposition was expressly repudiated by Professor Julian Huxley)—I can see no reason why a higher power may not far more subtly shape its ends and ours without any "interference" with its own laws.

"*In the light of our knowledge of physical science, do you regard it as intellectually legitimate to pray to God to alter the course of physical events—e.g., prayers for rain?*"

This question is partly answered in the reply to the first. It only remains to add that many prayers for particular ends are probably wrong, both intellectually and spiritually. *Fiat voluntas tua* is the model of all prayer; and it must be accepted that, if the general order of the universe were subject to capricious violation, the result would be universal chaos. This has been recognised by the greatest religious thinkers of all ages. Our own ignorance makes it impossible for us to pray aright in any other way than that laid down for us in the perfect example; but this does not invalidate the belief that, as a father may answer the plea of a child in ways that quite transcend the child's knowledge, so —if there be any freedom, or room for contingency in the universe at all—prayer for God's help according to His will may also be answered in unsuspected ways, the prayer itself being a new factor in the situation, and something unknown to physical nature, but proceeding from that part of ourselves which seems to draw nearest to God. I do not see how the error of those who think they can make beneficial suggestions to the Ruler of the universe can be taken either as evidence against the existence of the Ruler, or as invalidating the right kind of prayer, which I sincerely believe is often answered *through* the complexity of law.

This applies also to the third question; and I proceed to the fourth:—

"*Do you regard it as necessary to postulate the constant activity of God to maintain the processes of Nature, as was done, e.g., in regard to the course of the planets in pre-Newtonian astronomy?*"

If God be the origin, end, and permanent ground of all things, as shown by Spencer, the answer is certainly in the affirmative. The phrase "pre-Newtonian" indicates that Professor Julian Huxley does not know his Newton very well (*cf.* the quotation from Newton's creed given above, and also Newton's famous views on what he called the "sensorium" of God).

"*Would you agree that the Devil has almost entirely disappeared from the theological scheme of educated people?*"

Yes. He has rather a way of disappearing. And I don't see how he could do otherwise, if the scheme itself has disappeared. This question seems to be addressed to elementary intelligences. It invites a repudiation of horns and hoofs. Certainly no educated man believes to-day in the kind of devil Professor Huxley is thinking about. The Nicene creed, however, has no clause that I know of embodying the phrase "et in unum Diabolum." Nevertheless, Professor Huxley shall not escape; for "evil" has no meaning apart from personality; and our warfare, now as heretofore, is not with flesh and blood, but with the spirit of evil in high places.

If ever there were a time when the words of St. Paul were applicable, the time is now, throughout Europe, and especially in that part of Europe upon which Professor Huxley turns such glowing eyes, a country where Science has been "called upon to advise what religious impulses are intellectually permissible." The "advice" has been written in the innocent blood of thousands of those who dared to follow the most exalted figure in the moral and religious history of the world, and it has been written to the indelible shame of the pseudo-intelligentsia who condone it.

Professor Huxley does not condone their beastliness; but he thinks he sees, involved in it, the beginnings of a new evolution of religion, comparable with that of Christianity, and—apparently—destined to nobler ends. He seems to forget that, in the beginnings of Christianity, the killings and the persecutions were not the work of the Christians; and the most exalted moral figure that the world has ever seen was the first to be put to death. Does he seriously think that the men who on anti-religious grounds have been doing the killing of thousands of Christians in Russia are preparing a better religion? Does he seriously think that Lenin had even the germs of something better than the Author of "The Sermon on the Mount"? The pseudo-intelligentsia, of whom Professor Huxley certainly is not one, might

tell him so ; but I believe that one day, like the charming Devil in the story, he may himself face the distorted minds and perverse spirits who have been corrupting art and literature in recent years, and startle them with the plain, realistic announcement, " Gentlemen, you are every one of you possessed ! "

" After the general acceptance of the Darwinian principle of Natural Selection, is it scientifically necessary, or desirable, to postulate a Divine purpose to account for the apparent purpose seen in biological adaptation and evolutionary progress ?"

Darwin himself wrote, in the *Descent of Man*, " This grand sequence of events the mind refuses to accept as the result of blind chance. The understanding revolts from such a conclusion."

Darwin was one of the most honest men that ever lived. He knew very well what those words would be taken to mean. I refuse to believe that he was quibbling (although he emerged no further from his agnosticism). The words point, inevitably, to the fuller statement of Kelvin. " Science not only affirms, it postulates creative power. Creative and directive power Science compels us to accept as an article of belief. . . . We are absolutely forced by Science to admit and to believe with absolute confidence in directive power—in an influence other than physical, dynamical forces. There is nothing between absolute scientific belief in Creative Power and the acceptance of the theory of a fortuitous concourse of atoms."

Professor Huxley's appeal seems to be to the incredulity that we all entertain on the surface of our minds. But we live in an incredible world. This planet, we are told, was once lifeless. Place yourself, in imagination, on the shore of one of its lifeless seas, at that period ; and say to yourself, " Out of the chemistry of these lifeless elements, one sure and certain day, if I wait here long enough, the *Mauretania* will come sailing by, and a little boy will run up to me with a copy of *The Times* newspaper." Is this less or more incredible than the hypothesis of a Cause working through the " chemistry " and adequate to account for this production of plus out of minus ?

All the other questions, except the last, have been answered in the text earlier. Even in an article of this length it is impossible to cover the whole ground ; and I can only say that I have covered it more fully in my book. In answer to the last question—" Do you believe that such phenomena as conversion, mystic experience, etc., can be explained on naturalistic grounds, or demand the intervention of God or other supernatural aid ?"—I reply that nothing has ever been explained on naturalistic grounds ; nothing is " ordinary " in that sense ; nothing is without its roots in that Reality which is supra-rational and incomprehensible. Why, then, should I think that the deepest experiences of the human soul, mind, personality (or whatever name seems most " ordinary " to Professor Huxley) should be further removed from God rather than nearer to Him.

Let me add, in conclusion, that the sense of the sacred and eternal, *das Heilige*, as Professor Otto calls it, transcends the analysis of science, as the human affections transcend it, at their best and deepest, or as those imperatives for which men die transcend it. It is a sense as real as the sense of music, though I gather that Professor Julian Huxley has had no experience of it. He has spoken very frankly about things that multitudes (increasing, transcending the bounds of nations, and far more united than he dreams of) hold sacred. He must not mind, therefore, if I have spoken frankly in return. I share his dislike of abstractions ; and agree that the word " justice " may be as empty of content as any mere philosophic " principle." But I have not forgotten how, forty years ago, the sense of *das Heilige* touched me in that moving quotation by his grandfather, T. H. Huxley, from the Hebrew prophet : " What doth the Eternal require of thee, but to do justly, and to love mercy, and to walk humbly with the Eternal ? "

It was clear to me, even then, as I have said elsewhere, that so fine a head and so stiff a neck could hardly be thus bowed before a vague idea of endless duration or unlimited extension. Like Darwin, he was committed to more than he realised. It was an acknowledgment that, in the very nature of his Eternal, there were ethical requirements ; and this, again, implies the attributes of God.

The British Association, 1935

THE Annual Meeting of the British Association will be held next year in Norwich, from September 4th to 11th, under the presidency of Professor W. W. Watts, F.R.S. The following sectional presidents have been appointed : Section A (Mathematical and Physical Sciences), Dr. F. W. Aston, F.R.S. ; B (Chemistry), Prof. W. N. Haworth, F.R.S. ; C (Geology), Prof. G. Hickling ; D (Zoology), Prof. F. Balfour Browne ; E (Geography), Prof. F. Debenham ; F (Economic Science and Statistics), Prof. J. G. Smith ; G (Engineering), Mr. J. S. Wilson ; H (Anthropology), Dr. Cyril Fox ; I (Physiology), Prof. P. T. Herring ; J (Psychology), Dr. Ll. Wynn Jones ; K (Botany), Mr. F. T. Brooks, F.R.S. ; L (Educational Science), Dr. A. W. Pickard-Cambridge ; M (Agriculture), Dr. J. A. Venn. The President of the Conference of Delegates of Corresponding Societies will be Professor P. G. H. Boswell, O.B.E., F.R.S.

A Plant Hunter in the Sierras.

By P. L. Giuseppi, M.D., F.R.C.S.

Dr. Giuseppi, who has hunted for rare plants, Alpine especially, in many quarters of the globe, here tells of his exploits in the Spanish ranges, some of which are still rarely visited. His description was awarded the second prize in our travel competition for 1934.

SPAIN has great attractions for all kinds of visitors—architecture, picturesque villages, and scenic beauties—while for the keen plant collector it provides a rich harvest. The botany of Spain is interesting for several reasons. The Iberian Peninsula, like the Balkan, is much older geologically than the Italian, and for this reason many rare and ancient plants survive. Again, the Spanish flora is more closely connected with that of Morocco than with that of Europe; and, lastly, endemic plants are common in the Spanish mountain ranges because these are parallel with few connecting chains.

The great range of the Sierra Cazorla, north-east of Granada, covers over 100 square miles, and in all this great expanse no village and no road exists. The higher ranges rise to 8,500 feet and are thickly wooded with great pine trees. The whole of this area is a national forest and is beautifully preserved. The village of Cazorla is beautifully placed to the north-west of the mountains, and here a nice clean hotel is to be found. The going is so hard in the mountains that donkeys are the only beasts of burden that can make such a journey, and so, mounted on a hired donkey, I left for four rough days in this wild region. The limestone mountains are beautiful in outline, and their extreme whiteness is softened by the dark pine trees. The source of the Rio Mundo is at the foot of a semicircle of vertical rock over 600 feet in height. In the brilliant sunshine the white sheer cliffs seem stupendous; the huge pine trees are dwarfed to Noah's Ark dimensions, and the great eagles seem but flies. The two famous plants of the Sierra Cazorla are *Viola cazorlensis* and *Pinguicula vallisnaerifolia*. My first sight of the marvellous viola will always remain a red-letter day in my life. It is a strange commentary on the wildness of the Spanish sierras that this marvellous plant was unknown until 1902, when it was discovered by the French botanist Gandoger. The shady white cliffs were covered with little woody shrubs bearing huge bright pink flowers each with a long spur. This viola is closely related to *V. delphinantha* of Olympus and *V. koshanini* of Yugoslavia, and these three are the only survivors of a wonderful family. The Pinguicula is extremely rare and is found only on the damp rocks of waterfalls, but these it covers with its long yellowish-green leaves and huge dark purple flowers. Were it only for these two plants this mountain would be unique, but many others grace its stern white walls. Perhaps one of the most interesting is *Hypericum ericoides*, which

The Castle of Iruela in the Sierra Cazorla.

was described by Linnæus in 1763 and has not been seen since. The stems of this little shrub were entirely covered with tiny green leaves, and each bore at its summit three or four delightful golden flowers.

The first evening we arrived by a high upland valley on to the summit of Las Cabañas, a peak of 8,000 feet, and here we meant to sleep in a small hut. We found it tenanted by an old man who insisted that no one was allowed to sleep there but himself; by this time a cold wind was blowing, and so I assured him that we must sleep in the hut. Eventually I persuaded him to telephone to his officer in the valley below and read out a letter kindly given to us by the Spanish Ambassador in London. Official permission was thus obtained, and after a dinner of sardines, chocolate, and a water melon we went to bed on the stone floor of the hut, which measured 10 feet by 7. As there was a fireplace at one end and a badly fitting door at the other, sleep was well nigh impossible. One of us was slowly being roasted to death and the other was being frozen alive by the cold draughts below the door. Next morning we woke up to a new world on the mountain top, a carpet of flowers at our feet and all around a sea of white clouds which slowly melted away, leaving wondrous views of valleys below and endless waves of mountains. On another evening we were allowed to sleep on the floor of a kitchen in a remote cottage.

Here the son and daughter of the house were marrying next day another son and daughter of a distant woodman. The relatives were agog with excitement, and we drank countless toasts to the young people. Our retiring to bed was quite regal, for we were watched by three men and seven women. At about 3 a.m., after a sleepless night of countless toastings, we were aroused by a loud knock on our door, and when the old father asked who it was, he was answered "Juan." The future son-in-law had arrived for his bride. There was no more rest for us, for toastings began anew. In the meantime the future bride was being bathed in the neighbouring room by the women amidst an accompaniment of laughter and stories. Eventually, at 3.30 a.m., the bridegroom leapt on to his horse, the bride jumped up behind, and the happy couple rode away to their wedding in the little village church some five hours away.

On the Sierra Aznatín to the west I discovered the rare *Campanula cuatrecasasii* discovered by the Spanish botanist Cuatrecasas in 1926. This is a first-class plant with white leaves and large dark purple flowers. It is not in many European countries that one can to-day find a new plant of this importance.

The Sierra Nevada, farther south, is crossed by the highest motoring road in Europe, which ascends to 10,500 feet and is beautifully engineered. In the shelter below the Peña de San Francisco my wife and I spent a pleasant three days at 7,500 feet amidst wonderful views of the highest peaks.

On the first day we climbed from the hut to 10,300 feet on the Veleta, and we were quite sure of reaching the

The plant-hunters ascend the Dornajo, a peak of the Sierra Nevada.

summit in a short time, when suddenly it began to rain and hail and a cold wind swept down upon us. In a very few minutes we were sopping wet and shivering with cold. We hurried downwards and took refuge in a friendly cave into which we had to crawl, and there we sat on the muddy floor shivering and eating our lunch of sardines and raisins for an hour, until the rain had ceased. The wind blew a great gale, and before we had reached the refuge we were quite dry. We were delighted with our great haul of plants, among which were *Dianthus langeanus*, with delightful blue-grey foliage and pink flowers, *Arenaria nevadensis*, *Sempervivum nevadensis*, *Eryngium glaciale*, *Ptilotrichum purpureum*, and many other flowers. The next day we climbed to the Corral de la Veleta and enjoyed wonderful views of the neighbouring peaks, the Mulhácen, the Alcázaba, and many others. Around us a purple gentian of the *Acaulis* section, a golden *Doronicum*, and great sheets of *Chrysanthemum hispanicum radicans* decked the stony grounds with sheets of colour. In the Corral below lay the only glacier, a tiny one, but one of which the Spaniards are very proud. Next day we spent a happy time below the Albergue collecting the fly-catcher, *Pinguicula leptoceras*, with purple-striped white flowers, *Antirrhinum molle*, and many other plants. We returned to Granada on the following day on horseback, enjoying wonderful views of the two sister mountains, the Dornajo and other peaks, and collecting the delightful *Echium albicans*, the pleasant blue flowers of which turn red when fading.

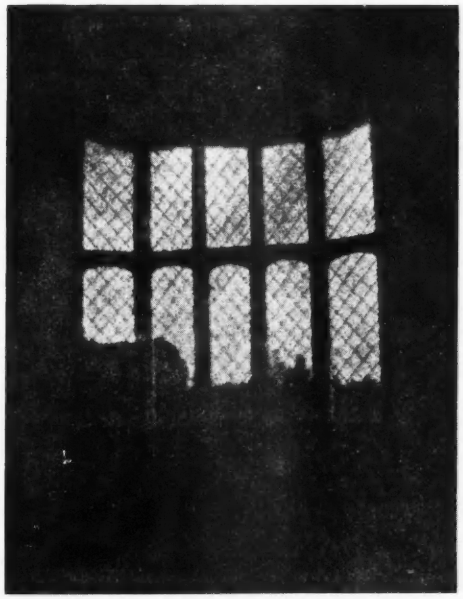
Coloured Fog-Lights

DOES a coloured headlight beam enable the driver of a car to see farther in a fog than when using a white headlight? In view of the interest and importance of the subject, the National Physical Laboratory at Teddington carried out a methodical series of tests during the heavy fogs of last winter to discover whether a satisfactory answer could be found to this vexed question. The results of the experiments have recently become available.

The distance at which an observer could just detect a test-object through the fog was determined, both with the unscreened headlights and employing glass filters of various colours—orange, red, and blue-green. Of course, altering the colour of a headlight beam by placing a coloured glass plate over the headlight also diminishes the intensity of the light. The results of the experiments point to the conclusion that the only effect on range of visibility in fog due to inserting the coloured glasses arises from this diminution of intensity, which is accompanied by a reduction in the penetration of the beam through the fog. The distance at which the test object could be discerned was the same with coloured glasses as with clear, colourless glasses, provided the intensity of the light, after passing through the glasses, was the same in each case.

The First Photograph.

To celebrate the centenary of photography in 1934, the principal photographic societies organised a series of exhibitions of modern photography, in which an exceptionally high standard of interest and brilliance was attained. Messrs. Elliot and Fry arranged at their own Baker Street gallery a smaller exhibition of early prints made by Henry Fox Talbot, the pioneer of photography. In connection with Fox Talbot's work a minor centenary falls in 1935, the hundredth birthday of the earliest existing photograph. A small paper negative, depicting a window in Lacock Abbey, Fox



The oldest existing photograph, taken by Fox Talbot in 1835, *depicts a window of his home at Lacock Abbey, Wiltshire.*

Talbot's home, is still in existence, a memento of the brilliant summer of 1835, and, by courtesy of the Royal, Photographic Society, we publish a reproduction of that photograph herewith.

The picture was taken on sensitised paper, probably with a small short-focus camera having a large-aperture lens. A long exposure was required and the negative image was fixed by immersion in a solution of potassium iodide. It was not until 1840-41 that Fox Talbot made his really important discovery, that of a latent image which could be chemically developed after exposure, thus doing away with the necessity of exposures of half an hour or more.

An interesting sidelight on these early days is reported by Mr. Herbert Lambert from the correspondence between Fox Talbot and Sir William Herschel. It was Herschel who suggested the word "photographic" (Fox Talbot's word was "photogenic" . . . years before the days of film stars) as well as the useful terms "positive" and "negative."

Irish Antiquities.

THE account of the activities of the Harvard University Archæological Expedition in Ireland given by Mr. S. Casson in *Discovery* last October may be supplemented by reference to the very important results which are being obtained by co-operation with Mr. C. Blake Whelan in the excavation of Stone Age sites in north-east Ireland. Mr. Whelan hopes eventually by the correlation of a number of sites of varying age and stages of culture, which he has already identified tentatively, to work out a cultural and chronological sequence which will throw light on the obscure problem of the development of the mesolithic and early neolithic phases of culture in western Europe leading up to or related to the Campignian industry of the early neolithic, of which the type station is Campigny in Seine Inférieure, France. At present the Continental problem is obscured by the fact that comparable chronological and stratigraphical data are lacking; but these Mr. Whelan hopes it will be possible to supply from the evidence to be obtained on the sites of north-east Ireland. It will, therefore, be seen that his investigations are of first rate importance, not only for the archæology of Ireland, but also for study of the development of Stone Age cultures in Europe generally.

The Harvard University Expedition is giving valuable assistance in attacking the Irish sites and a report on the examination of a Campignian site at Ballynagard, Rathlin Island, Co. Antrim, has already been presented to the Royal Irish Academy, in which it is shown that the Irish Campignian is fully comparable with the type culture at Campigny, while the pottery, which has been adjudged similar to that of the English station of Windmill Hill, brings it within the general cultural complex of the early neolithic in western Europe. Further excavations on Rathlin Island during the past summer have brought to light a series of stone cists on a valley terrace in which the low retaining walls, surmounted by stone slab covers, are surrounded by charcoal and ash containing ox-teeth, stone pounders, fragments of flint implements and flakes, and a quantity of crude pottery fragments ornamented with incised

lines, the whole probably representing the debris of a funerary sacrifice.

More recently other excavations have been undertaken at Cushendun and on the peninsula of Islandmagee, both also in Co. Antrim. At Cushendun relics of all the four Stone Age cultures of Ireland were discovered, one above the other, leaving no doubt as to the order in which they were deposited; no traces of palæolithic man have so far been discovered.

Of a totally distinct period are the finds from the Crannog, or lake-dwelling at Lagore, Co. Meath. The palmy days of this once royal residence extended from the 8th to the 10th century, but evidence of much older occupations likewise appears. Personal ornaments of bead, bronze, and bone were among the most characteristic objects discovered here.

Carrickrobin, Co. Louth, has yielded an interesting find to the Rev. F. Corcoran, a noted local archæologist. A stone fragment found there, and now deposited in the National Museum, exhibits the spiral and concentric ornament characteristic of the famous tumulus Brughna-Boinne, at Newgrange, Co. Meath, dating from 2000 B.C.

Ionised Oils for Fibre Treatment.

As the result of tests extending over some years it has been discovered that "ionised oils" (mainly composed of blends of vegetable oils) form excellent batching and processing media for all vegetable fibres such as sisal, hemp, jute, New Zealand hemp (*Phormium tenax*), Columbian pita, and also flax, cotton and ramie, and even artificial silk. In the case of flax there is every possibility of the process having a revolutionary effect on the industry. This fibre, when treated by immersion before spinning or processing, yields a definitely improved yarn or fabric—it is whiter, softer and less creasable, whilst the loss in bleaching and finishing is considerably lowered and the solubility (or strength) is not impaired. With bast or "hard" fibres such as sisal, hemp and tenax, treatment in ionised oils enables these to be split up into their finer filaments, thereby providing new outlets and opening up new uses in the making of fabrics, upholstery and ribbonised fibre for straw hats and tapestry, etc.

Sisal rope and twine when made from fibres which have been batched or treated with the oils are more flexible; they are better in colour and of a higher flotation value. In this respect a new blend combining soluble wax compound is used for enlarging and impregnating the fibres, thereby bringing the resistance to water absorption nearer to manilla hemp. Coir (coconut fibre) has even been retted and softened enabling it to be spun and used for purposes deemed impossible.

In the jute industry the application of ionised oils has advantages which should eliminate the troubles which undoubtedly emanate from some of the "batching" fluids at present used in many mills, and when used as a "batching" fluid no emulsifying agent is necessary. Jute fibre which has been softened and bleached with the oils possesses a softness, flexibility and the possibility of finer fabrics than hitherto; here, again, it may open up many new fields and directions which may mean revival in an industry which has suffered badly of late.

For batching and processing fibres, the oils are mixed with water or any other compound or material and applied in known manner. For softening and bleaching, a solution of ionised oil, comprising one part of oil to 6 or even 12 parts of water, is made up and maintained at about 180° F., the fibre being immersed for a period which varies from $1\frac{1}{2}$ to $3\frac{1}{2}$ hours, according to the degree of softness and colour which it is desired to obtain. During immersion, the fibres are rolled or compressed several times to exclude the hardened gums and residual fleshy matter.

The Ionising Process.

Ionised oils are also being used in other industries, including wool, feathers, furs and skins, toilet preparations, laundry work, carpet making and paint manufacture. They are manufactured by H. G. Products, Ltd. The process of manufacture is such that the oils are first treated to a modified and improved sulphonation process, followed by three other stages, including electrolytic treatment and ozone impregnation. As a result of these processes the oils are perfectly water-miscible, light in colour, non-oxidising, and non-inflammable. They possess definite scouring and wetting-out properties, have softening effects on vegetable and animal fibres, and bring about the loosening of vegetable fleshy matter and gums. In addition, they have bleaching and lubricating qualities, will emulsify with other oils (either mineral, animal or vegetable), and are saponifying and penetrating. Finally, they are highly antiseptic, bactericidal, and fungicidal.

Science Talks

READERS of *Discovery* will be glad to learn that Dr. A. S. Russell, whose name as a contributor is familiar to them, will, with Dr. John Baker, be responsible for a new series of wireless talks on recent scientific discoveries in the National Programme on Mondays at 6.30 p.m.

Book Reviews.

Alpine Pilgrimage. By DR. JULIUS KUGY; translated by H. E. G. TYNDALE. (Murray. 12*s.*)

The reasons for which men go up into the high hills are as diverse as are the individualities of mountaineers. Dr. Julius Kugy became a mountaineer because he is a nature lover, and for him Nature finds her fullest and fairest expression in the mountains, their flowers, rocks, and snows. He is also intensely vital, and, as he found life richer and deeper in the mountains than in the plains, he turned to them for fuller life as well as for life more beautiful. He has written several books which reveal how closely his experiences as a mountaineer were bound up with the rest of his busy life. The German title of the book now translated and under notice (*Aus dem Leben Eines Bergsteigers*) has been aptly rendered in English by *Alpine Pilgrimage*. It sums up the life of one by whom the great Pilgrimage could be expressed only in terms of communion with the mountains. In his native city of Trieste, Dr. Kugy was from the very first near the most beautiful of the Eastern Alps—the Dolomites, the Mountains of Carnia, the Carnic and Julian Alps. And though he subsequently travelled and climbed throughout the whole extent of the European Alps, his heart was at home with the eastern ranges, and among them his special favourites from first to last were the Julian Alps. The Julian Alps take up a large part of his *Alpine Pilgrimage*, not in virtue of size or height, but for the variety and charm which none can escape that come their way. There Dr. Kugy achieved many first ascents, notably that of the Suhi Plaz, more generally known as the Skrlatica (Scarlet One), highest peak but one in the Julian Alps (about 9,000 feet). The Kugy Ledge below the summit rocks of Triglav is named after him in honour of his first traverse of this perilous route, previously known only to the most daring of hunters and poachers. Dr. Kugy's best climbing days fell into the happy pioneering period in the "seventies" of last century, when accessible mountains still offered first ascents possible without all the paraphernalia of ironmongery and tackle necessary to the climber who would establish a record in European mountaineering to-day. But it is doubtful whether Dr. Kugy would ever have climbed otherwise than he did. For him, the resources and the message of the mountain were the thing, the achievement of a deed of daring or novelty always a secondary consideration, an incident, not the essence of mountaineering. He was an all-round naturalist, with a special interest in botany, and one of the most fascinating chapters of the book is that dedicated to the search of the elusive *Scabiosa trenta*.

His guides he found among the chamois hunters and poachers of the sequestered valleys of the Eastern Alps—Sava, Trenta, Raccolana—mere names to those who do not know that region, and haunts of supreme beauty to those that have wandered there. And what a company of good fellows he gathered together! Andreas Komac, Oitzinger, Osvald Pesamosca, names of locally classic heroes, and now made memorable by this book in the world beyond their mountains. Through it all rings the song of praise of the mountains, his ardent love for them and gratitude for all that he owed them. Dr. Kugy gave up climbing in 1918. But he still spends as much of his time as possible among the mountains near Trieste. He is a frequent guest at the country house of his friend, Monsieur Albert Bois de Chesne, whose holiday occupation is a beautiful Alpine Botanical Garden (*Juliana*) at Santa Maria in Trenta, near the source of the Isonzo, usually referred to by its Slav name of Soca in Dr. Kugy's book. But the recognised Alpine home of Dr. Kugy's later years is in the delightful village of Valbruna (Wolfsbach) in the heart of those mountains which are, perhaps, his greatest favourites of all—in the Eastern Julians. He is the "Onkel Julius" of an entire younger generation of cragsmen, beloved, revered, consulted by all. His interest in mountaineering all the world over is undiminished, but each new mountaineering feat in his beloved Julian Alps or in Carnia is a matter of special importance to him.

Of the books which Dr. Kugy has written since his retirement from active mountaineering, *Alpine Pilgrimage* will probably remain the most notable. Mr. Tyndale's translation into English has been done exceedingly well, in spite of the difficulty of rendering prose which is often poetry in all but outward form. The "List of Alternative Names" at the end is particularly useful, as these are the names that appear in all modern maps, are generally in local use, and therefore are the names that the foreign visitor to those parts will find it to his advantage to know.

The Biology of Bacteria. By A. T. HENRICI (Harrap. 12*s.* 6*d.*)

Professor Henrici's book on the biology of bacteria should be welcomed by those who regard bacteria as a little more than a symptom of a disease or a constituent of the soil. In his preface Professor Henrici states that the book is written for non-technical students who are taking one course on micro-biology, nevertheless anyone interested in bacteria as bacteria, rather than in what they do, will find here a very adequate textbook. Presumably for the curriculum of the American University bacteriology at times becomes microbiology, for other unicellular types, e.g., Protozoa, Algae, Molds and Fungi, are included. The main part of the book deals with the bacteria, their life and death, behaviour and activity; the book's longest chapter deals with the metabolism of bacteria. While not wishing to indulge in mere carping criticism, one cannot help feeling that it is a pity that growth and reproduction were not accorded chapters of their own, and a space found for an account of the lag phase of growth and the many hypotheses that have been put forward to explain this curious phenomenon. If the life cycle in the bacteria is mentioned rather frequently throughout the book, the author views this very controversial question with a far more critical standard than many of his countrymen and gives the experimental facts only the merit they deserve.

No textbook on any group of organisms can ignore the parasitic members of that group. However one views the bacteria it must be admitted that the parasitic bacteria are a large and important group in which every stage of facultative and obligate parasitism can be found. Something of the behaviour of the pathogenic bacteria must be included in a textbook on general bacteriology. This Professor Henrici succeeds in doing, dealing with the main points of Infection and Resistance without getting lost in the complexities of Immunity. A short chapter deals with the particular points of the bacterial diseases of plants.

The second half of the book covers the whole of the classification of the bacteria with chapters on the Molds, Yeasts, Pathogenic Protozoa, and Virus Diseases. A very good introductory chapter points out the particular difficulties in classifying bacteria, and the use of the word "species" in bacteriology. But in his description of these species the author is not so happy, as he has worked on the principle of mentioning everything, in

the limited space at his disposal. This means that many little known and unimportant organisms find a place at the expense of their more important relatives, and many type species, both pathogenic and saprophytic, are inadequately dealt with. With a few exceptions the illustrations throughout the book are good. This book should be of real value to the student of bacteriology, by itself for those who wish to learn something about the bacteria themselves, and in conjunction with a book on applied bacteriology for those whose chief interest is the application.

The Exploration of the Pacific. By J. C. Beaglehole. (A. & C. Black. 15*s.*)

The glamour inherent in the pioneer is intensified in the story of the exploration of the Pacific. From the time of its first discovery it held out golden hopes of a new way to the East; and for nearly three hundred years the dream of a *terra incognita* was a lure to adventure. The story ends with the tragic fate of Captain Cook. For he, by dissipating the geographical myth of a great southern continent, had demonstrated finally the realities of the southern hemisphere, which had been the subject of speculation from the time of the first rational attempts to understand the conformation of the earth.

Dr. Beaglehole, in introducing his story of the exploration of the Pacific, points out that between the 16th and the 18th centuries, the period with which he is concerned, it falls into three phases, in each of which the voyages of discovery were inspired by a different purpose. In the earliest phase the Spaniards sought to expand their dominion and increase their wealth. The Dutch, who followed them, desired to extend their commerce. The English and French alone in the 18th century entered upon this exploration with a sincere desire to add to scientific knowledge of geographical facts. This is fully borne out by the secret instructions issued to Captain Cook by the Admiralty which have recently been published. This distinction in the national aim is well brought out by the author in his account of individual voyages from Magellan to Cook; and in the long list of explorers, although it contains such great names as the Quiros, Tasman, Dampier, and Bougainville, there is none which outshines either of these, the first and the last. The account of Cook, in particular, brings out the elements in his character and attainments which combined to make him one of the greatest of explorers in any field.

Dr. Beaglehole has a great story to tell and he has told it well. His view that it is a story which will always be incomplete until it has been told by a member of one of the native races of the Pacific holds out fascinating possibilities, which, if realised, might not be entirely flattering to the memory of some, at least, of the European voyagers.

Quest for Birds. By W. K. Richmond. (Witherby. 7*s.* 6*d.*)

Mr. Richmond in his Preface says that certain chapters in his book were bound to be highly contentious, and this they certainly are; but at the same time they are stimulating. The author has thought for himself, and is not afraid to say when he differs from ornithological authorities. He deprecates the attitude of a certain type of scientific ornithologist—"who spends his time in collecting scrupulously scientific data . . . and insists that unless we follow his example we have no claim to the title of ornithologist." Rather, the ornithologist of to-day must above all "be a man with an inner passion for birds"; he must be tolerant and broadminded; "the scientific ornithologist may possess half the truth; the plain bird-watcher certainly possesses the other half, but neither by himself is convincing." These words should be weighed carefully by all students of bird-life, whether scientific or æsthetic.

Writing on "The Balance (?) of Birds" the author cannot agree with Mr. E. M. Nicholson's contention that the losses in English birds which we have undoubtedly suffered during the last 400 years have been compensated by the appearance of new species. Such a state of affairs is most unlikely. The menu which he quotes of a banquet given by Archbishop Neville in 1465 is significant. It begins with 1,200 quails and includes 200 bitterns. It may be true that since then England has become a land of small, rather than large birds, but it is difficult to believe that even the smaller species have increased when we consider the rapid growth of industrialism, with its attendant spoliation of the countryside.

Mr. Richmond picks a good many holes in Mr. Eliot Howard's territorial theory, which has, indeed, from the time of its first appearance, been subjected to severe criticism. In fairness to Mr. Howard we must not forget that in his introduction to *Territory in Bird Life* he wrote "much is mere speculation; much with fuller knowledge may be found to be wrong." Mr. Richmond believes that the theory is "valid up to a point." He is quite right when he says "Bird life will never be explained by a formula." His impression is that "territory is never such a clear-cut or so strict an affair as its exponents have made it out to be. It depends very largely on how intolerant or pugnacious the individual bird may be." Our own belief is that Mr. Howard's theories have been given too general an application. It is difficult to apply the territorial theory to many species; still less do all individuals conform to it, as an examination of the nesting habits of the birds frequenting one's own garden clearly shows.

In a chapter entitled "Spring Song," Mr. Richmond combats the theory that song is chiefly territorial, and that extra-territorial songs are sub-songs. He detects no difference between songs in or outside a territory; nor, we may add, have we ever been able to do so. Sub-song there is, e.g., of the robin, but it is a distinct type of song, and not confined to extra-territorial performances. Surely the truth is that song is an outlet for any of a bird's emotions, joy, fear, anger, jealousy, but chiefly *joie de vivre*; he sings because he must, and not to prove or disprove a theory.

The study of bird-mind is fascinating to all field-naturalists. Mr. Richmond realises that the life of birds is almost entirely sensory: most of their actions spring from instinct; "perceptual" intelligence they have, but how far they are "conceptually" intelligent is a more difficult point. Tertiary behaviour—the ability to conceive an abstract concept—is usually supposed to be absent in birds, and indeed in beasts. Mr. Richmond thinks that most species have "a vague incipient sense of conceptual intelligence, and that in certain individuals it is developed much more than in others." We think this an over-statement, and the examples he quotes seem capable either of a perceptual or conceptual interpretation. Only by careful observation of individual birds can the truth of such theories be tested, and the difficulties in the way are only too well known to field-naturalists.

We consider this to be one of the most important bird-books that has appeared recently. Its sincerity, thoughtfulness, and breadth of outlook will appeal to all who know birds; if it suggests to some ornithological oracles the advisability of reconsidering their dogmas it will have done good work.

Newton and the Origin of Colours. By MICHAEL ROBERTS and E. R. THOMAS. (Bell. 3*s*.)

It would be safe to say that there are only two kinds of minds, the interpretative and the creative, and that both are essential to each other, for every step in the progress of knowledge is made through the jambs of previous theory. But it is necessary further to distinguish between two kinds of interpretative minds, which while not thus mutually dependent are equally valuable. There is the kind which may be termed the "Professorial" or academic, the duty of which, in the majority of cases, is to be the melting-pot and meeting point for current tendencies in thought, and to pass its knowledge on to others receiving academic training; and there is the interpretative mind—equally important—which seeks to translate the findings of creative minds into terms understandable to those unversed in the technical details in which a theory is clothed. Until the theories of creative minds have "soaked," by this method, into the intelligent thought of the period, and thus become part of the current *Weltausschauung*, the door is not open (the jambs being too narrow in fact) for further progress to be possible. This introductory paragraph is intended to give a suitable indication of the importance of the work Mr. E. R. Thomas is doing in editing the "Classics of Scientific Method" series, in which the present volume is included.

We are told in the course of the book that it is written "to show Newton neither as a monster nor a miracle, but as a man; to define the limit of the Newtonian claims on the one hand and on the other the origin and growth of his ideas." To say that the authors have succeeded in this task—and I hope I have indicated its importance—would be sufficient praise, but it would not reveal the scholarly work which has gone to the making of the book, nor the lucid method adopted in presenting what would otherwise be a difficult and obscure subject. The book is filled with copious quotations from Newton's own writings, which in itself constitutes a reply to those who claim that a popular exposition must inevitably lead to falsification and misrepresentation. Within the book is included also a reprint of the paper that Newton delivered to the Royal Society describing the thoughts and motives which led up to his discovery of how ordinary light could be separated into the colours of the rainbow, a brilliant example of scientific method. All Newton's relevant correspondence on the issues which this paper raised are included along with introductory chapters which not only trace the origin and development of the method, but also show how the work of Newton, and his great contemporaries, Hook and Barrow, grew out of their earliest interests and preoccupations.

To Mr. Michael Roberts is due a well-written and stimulating introductory chapter on "The History of Scientific Method," depending in some places on account of its brevity, on assumptions which in a larger thesis would require a good deal of justification. For instance, in one place he claims that the objects and purposes of our thoughts are constantly being changed by new scientific discoveries, and new economic conditions. To a large extent such a claim is perfectly true, but does it not leave out whole tracts of possible activities of the mind? It is quite true that *nihil est in intellectu quod non fuerit in sensu*, but what about the mind itself? Is not epistemology, for instance, a quite legitimate exercise of the mind, independently of any conditions—economic or scientific? But to stress such questionable assumptions would be to give a wrong impression of the general soundness of his position. To call attention too strongly to his omissions (for instance, there is no mention of the sceptical attitude to science which from Berkeley to Russell and Broad has insisted on the hypothetical basis of its generalisations) would be mere cavilling in view of the wealth of detail and breadth of vision which find expression in the essay.

The book is one that can be wholeheartedly recommended to all readers of *Discovery* as it does in fact, fulfil a similar function in interpreting creative progress to the intelligent.

The Men of the Last Frontier. By GREY OWL. (Country Life. 6*s*.)

Grey Owl, whose father was a Scot, took this name when adopted as blood-brother by the Ojibway, so that he became a woodsman unlike his mother's people, who were Apaches of the plains of New Mexico. This ancestry explains his sympathy with the wilder aspects of Nature, and with the Redskin, whose spirit he is thus able to interpret to us. Even when shorn of his Fenimore-Cooperism, which the author himself deprecates, the Indian has much to teach us that commands our respect. Grey Owl has lived, too, so near to Nature that he realises that not only the Redskin, but the white trapper also is part of that Nature. These men, in his words, are closing for ever the book of romance in Canadian history, a chapter which, when stripped of its glamour, is as harsh and pitiless as any industrial moloch. Read the passage describing the virtual extermination of the beaver; it is a terrible story, little known or realised on our side of the Atlantic, and, apart from the humanitarian side, a sharp lesson in the folly of killing golden geese. Even in the bad old days, however, there are some things on which Canada may well pride herself. While the Americans were fighting a war of extermination with the Indian for the conquest of his land, if the Americans won it was called a glorious victory, but if the Indians won, a horrible massacre. That war was pitiless, but on the Canadian side the penetration was peaceful, so that the Indians came to see there the light of a sanctuary. Still, the result is the same in the long run, and the Indian is an outcast in the land of his fathers.

It is interesting to compare conditions in Canada and Siberia. In both the temperature may fall to 100° of frost, when it "cuts like a scimitar of chilled steel," but Grey Owl does not mention the Arctic fog that goes with those great frosts in Asia. The *iziubr* appears as the wapiti, the elk as the moose, but the Indians have not domesticated the caribou as the Siberians have the reindeer. Nor have the Indians, it seems, the Tungus method of wearing down the moose through the snow, which is surprising, as it is worth the effort to secure enough meat to keep a man half the winter. The author appreciates the incomparable beauty of the north, for he has lived in those vast solitudes where a man may go insane from silence. Yet he does not mention that profuse carpet of whortleberries that is one of the solaces for the cruelty of the *taigá* of Asia.

Grey Owl is an animal lover. Although he lived for years by killing beavers, yet his eyes were opened, and he learned to love these mischievous and destructive creatures, finding in them affectionate pets, whose intelligence seems to resemble the human.

Like mountaineers, the author has a poor opinion of the value of the compass, the use of which becomes mechanical.

There are many striking passages in the book, notably that dealing with the terror of forest fire, and of the fearful storms that spring so suddenly with such destructive energy. The most impressive, perhaps, is the Trial of Two Sunsets, the dirge of the dying Indian, with no hope for the future, only memory of the past. Grey Owl has considerable power of expression, a vigorous phraseology. Our chief criticism is that he is too

impersonal, and descriptions of his own adventures are too few. He has misunderstood the expression "pot-hunter," and in his diatribe against the battues of Europe, has not grasped the distinction between hunting for *a* pot and hunting for *the* pot.

The Circulation of the Blood. By WINIFRED PARSONS. (Sheldon Press. 5*s*.)

It is only just over two hundred years since it was first demonstrated that the blood in the arteries exerts a high pressure against the elastic walls of the arteries and is thereby pushed forward into all their branching sub-divisions. This was the result of an experiment by the Rev. Stephen Hales in 1733.

In 1628 William Harvey, physician to St. Bartholomew's, had published his classical Latin essay on the movement of the heart and blood, in which he showed that the heart causes the blood to move constantly in a circle. In that same year was born Marcello Malpighi, an Italian, who in 1661 investigated the peculiar capillary action of the blood vessels of the lungs and ultimately showed that blood did not escape from the ends of the smaller arteries into spaces in the tissues, thence to be collected by the mouths of the smaller veins, but was actually enclosed in a continuous network of minute blood vessels which were fed by arteries and drained by veins. This network, which connects the arterial and the venous systems, is now spoken of as the capillary system, and it is composed of tubes so fine that nobody suspected their presence until Malpighi made his discovery with the aid of the newly-introduced microscope.

The early investigations on blood and its mode of circulation are of great interest, but Miss Parsons has much more to tell us about the intricate meanings of "the circulation of the blood," which is one of the most important of our bodily functions. She approaches the subject from the broad evolutionary point of view and includes a study of the circulatory mechanisms which are found in typical and familiar members of the animal kingdom —earth-worm, salmon, frog and swan. Subsequent chapters deal with the blood, heart and blood vessels of man; the heart in action; pressures and pulses; the control of the heart; special circulatory arrangements; tissue fluid and lymph; and the electrical currents of the heart.

The Bucheum. By SIR ROBERT MOND and OLIVER H MYERS, with the Hieroglyphic Inscriptions edited by H. W. FAIRMAN. Three Vols. (Egypt Exploration Society and Oxford University Press. 50*s*.)

These three volumes constitute the official report on the results of five years' work at Armant on the site of the Bucheum, a centre of a previously unknown bull-cult of Ancient Egypt. A preliminary account of the excavation appeared in *Discovery* in July, 1931. In the first of the three volumes Sir Robert Mond reports on his discovery of the site and the progress of the excavation, and the finds are then described in detail. The second volume contains the inscriptions, the study of each class: demotic, Greek, etc., being entrusted to an expert and the whole edited by Mr. H. W. Fairman. The plates, 106 in collotype and 96 in line, make up the third volume.

The tombs of the sacred Buchis bulls have provided a wealth of information relating to this interesting cult, not only concerning the bulls themselves, but also the cows (the mothers of the bulls) and the officials by whom the cult was carried on. The whole subject of the worship of the bull in Ancient Egypt has been reviewed, and the material obtained from the Bucheum compared with that available from other centres of the worship as far back as it can be traced.

The publication of the results has been carried out with meticulous care; and it is no exaggeration to say that few, if any, previous excavations have been dealt with in publications of greater elaboration. The illustration is as full and as high in quality as the most exacting of students could demand. In dealing with special topics such as architecture, metallurgy, pottery, music, and the like, the assistance of experts has been freely asked and as freely given. It is not surprising to learn that the Report is sold below cost.

The Electronic Structure and Properties of Matter. By C. H. DOUGLAS CLARK. (Chapman and Hall. 21*s*.)

Facing the title page of this volume details are given, chapter by chapter, of two other volumes which are in preparation. "A Comprehensive Treatise of Atomic and Molecular Structure" is projected, and these are to be the first three volumes. The general preface indicates that volumes beyond the third will be devoted to "matters of special chemical importance"; the first three "deal with different aspects of more purely physical questions." It may be said at once that these purely physical questions, except in one chapter in volume 3 (The Interpretation of Band Spectra), do not touch the problem of the structure of the nucleus; with this exception, however, it appears that the survey of data of which the interpretation is in terms of atomic and molecular structural categories is indeed comprehensive.

Necessarily, this comprehensiveness itself results in a survey which is very severely condensed in form. There is ample machinery for condensation, however. A complete system of cross references, symbols and abbreviations has been set up, of which, perhaps, it is as yet too early to judge the final utility. But we may express the hope that the machinery will remain servant without usurping the mastery. For cross references alone suggest that, whatever stage the writing of the second and third volumes may have reached, this much at least is fixed, that chapters, sections and sub-sections have been assigned their topics. Development will not easily escape these fetters. Here, however, we are primarily concerned with the development of the first volume of the Treatise. There are 374 pages of text; 87 of them are occupied with indexes and lists of references. Complete titles of more than one thousand papers are given. To each of these, on the average, considerably less than ten lines of print has been devoted in the body of the work. Obviously it is very difficult to write in an easy style under such limitations, though in places, where the results to be described are qualitative rather than quantitative, this limitation has been overcome and an account of considerable grace of presentation has resulted.

The volume is divided into two parts. The first describes the electron structure of individual atoms (concluding with a short chapter on the interpretation of valency), standardising nomenclature and keeping the Periodic Classification always in full regard. The treatment is even more condensed than that promised of much the same subjects in volume 2, part 3. Part 2 represents the beginning of the systematic survey of various properties of matter from the point of view of electronic structure. Change of state, the volumes of atoms and molecules, electrical conductivity, magnetic susceptibility and cohesion are treated here. Granted the author's aim, there need be no serious criticism of its realisation. The book is intended as a guide to the literature; that is a strict estimate of the field of its success.